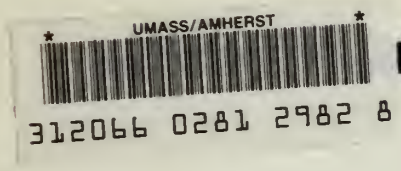


Suburban Public Transportation

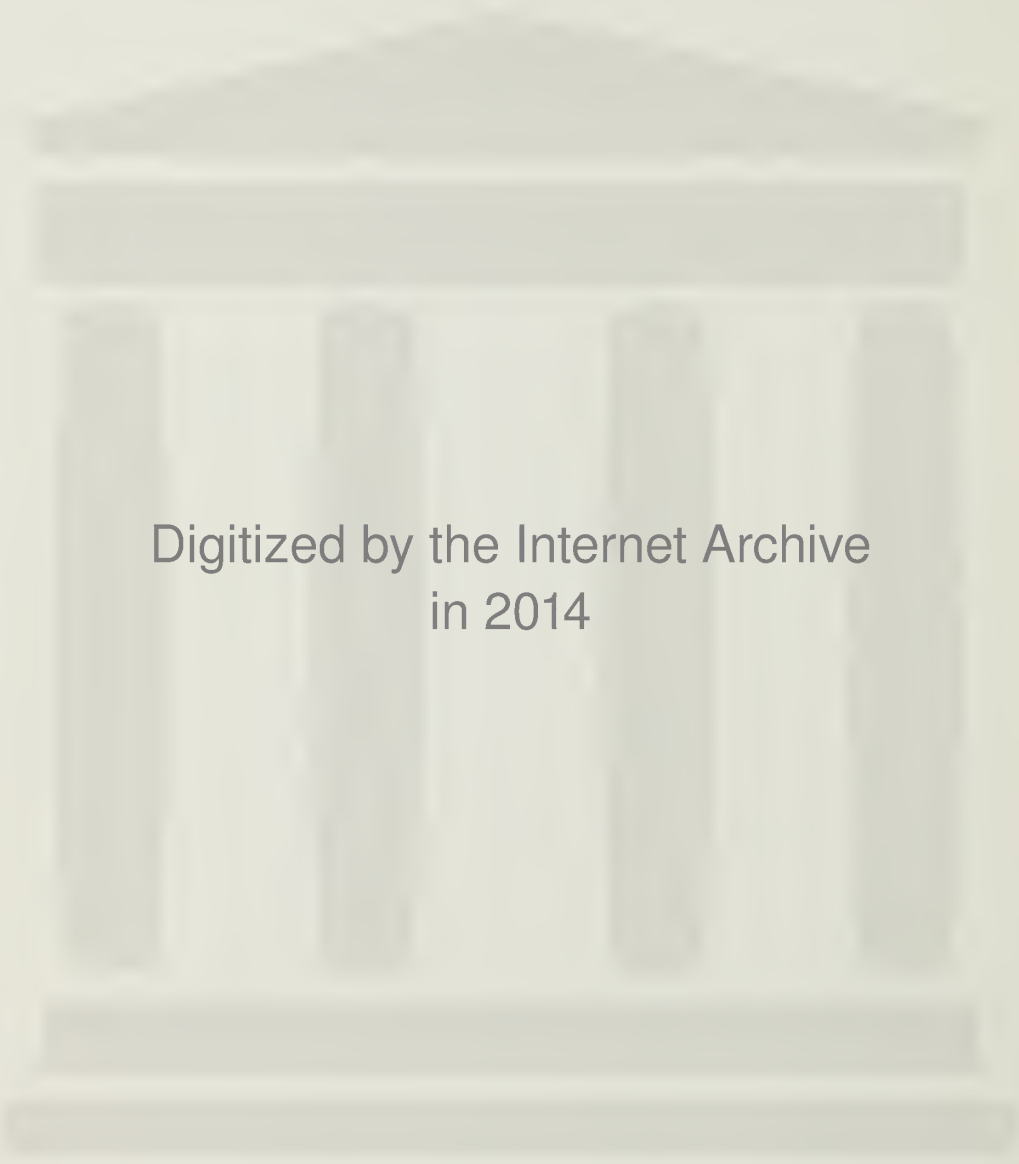
A paper prepared for the

Boston Metropolitan

Planning Organization by

the Central Transportation

Planning Staff



Suburban Public Transportation

Author
Stephen Falbel

Contributing Analyst
Adam Rahbee

Graphics
Stephen Falbel
Kenneth A. Dumas

Photograph
Carol Gautreau Bent

Cover Design
Jane M. Gillis

The preparation of this document was supported by the Federal Transit Administration through EOTC §5303 Contract 8169001 and state matching funds.

Central Transportation Planning Staff
Directed by the Boston Metropolitan Planning Organization. The MPO is composed of state and regional agencies and authorities, and local governments.

August 1998

ABSTRACT

This paper examines the theory and practice of public transportation in suburban areas. The first section considers the concept of "the suburbs," highlighting the variety of environments that make up the suburban portion of a metropolitan area. Next, the various types of public transportation and the environments in which they are successful are described. The third section discusses the several factors that affect a person's choice of transportation mode (driving alone, carpool/vanpool or transit). An overview of the Boston region's experience with suburban public transportation is then presented as a basis from which to investigate potential increases in service.

An expansion of transit service in the suburbs is considered in three segments of the travel market: suburb-to-suburb, city-to-suburb, and intrasuburb. The types of service most appropriate to each segment are identified and discussed. Finally, the short-term and long-term impacts of the potential expansions of service are analyzed. The paper concludes that an increase in public transportation service, absent major changes in land use and parking policy, would likely have little or no effect on suburban congestion, though it would be of benefit to people who are not able to drive.

For additional copies of this document or to request it in accessible format, contact:

Central Transportation Planning Staff
Ten Park Plaza, Suite 2150
Boston, Massachusetts 02116-3968

(617) 973-7100
(617) 973-8855 (fax)
(617) 973-7089 (TTY)
ctps@ctps.org (e-mail)

TABLE OF CONTENTS

INTRODUCTION

Public transportation has traditionally been associated with urban environments. The primary reason for this connection is that public transportation has been historically roughly equivalent to mass transit, that is, moving large numbers of people, usually on some fixed route on a fixed schedule. Only in cities, or on routes leading to and from cities, have there been sufficient numbers of people moving in the same direction at the same time to make operation of large capacity vehicles (able to hold more than, say, fifteen people) economical.

Economy was important in the development of public transportation, because much of it, until the middle part of the twentieth century, was built and operated by private, profit-seeking companies.[1] As transit systems became publicly subsidized (starting as early as the 1910s) and eventually publicly owned and operated, the role of transit as a public necessity and a public good became clearer: transit affords all people in the service area with mobility, and it offers an alternative to driving with the resultant benefits of less roadway congestion, environmental pollution and energy consumption.

Transit has had less of a role in suburban areas, where the automobile has been the dominant travel mode, especially in the period since 1950. Of course, there are many transit routes connecting suburbs to the central city of a metropolitan area. There are also local transit services in some suburban towns. Nonetheless, public transportation service makes up a relatively minor part of the total transportation activity in the suburbs, compared to transit's share of the activity in an urban area.

Two factors have spurred a call in recent years for increased transit service in suburban areas. The current economic expansion has filled vacant office space and led to new development in both the city and suburban job centers. The newly created jobs and increased economic activity have resulted in significant increases in traffic congestion. Some officials in suburban areas have looked to transit as a means to relieve this roadway congestion.

The second impetus for increased transit is a growing need for mobility. As has been well documented elsewhere, the number of senior citizens will increase significantly over the coming decades. In addition, there has been much publicity about "welfare-to-work" initiatives—that is, getting welfare recipients, who are concentrated in the inner cities, out to the suburbs where many of the jobs are.

---

[1] This is not to say that street railway companies building transit lines at the turn of the century succeeded in earning profits. Many of these companies had unrealistic expectations about potential ridership and ended up building lines which had no hope of ever being profitable. Also, note that while most transit systems were privately owned and operated, they were regulated by the government as public utilities.

Children and teenagers in the suburbs suffer from a lack of mobility and must often rely on their busy parents to drive them to their many activities. Finally, advances in medicine have helped people with disabilities to have longer, more active lives, although not necessarily the ability to drive. These parts of the population, as well as others, would benefit from the enhanced mobility that increased transit service in the suburbs would offer.

This is not to imply that there is some specific type of transit service which will fulfill all of the needs described above. Rather, there are three different transportation markets embedded in these needs. The first is suburb-to-suburb, which mainly concerns peak-period commuting trips. Data from the U.S. Census and from employer surveys show that employees at suburban job centers come from all directions, some from great distances. As they commute to and from work, almost all of them driving alone, suburban highways and arterials are overwhelmed.

A second market is city-to-suburb and comprises "reverse commuters." In addition to people moving from welfare to work, this market includes other city dwellers whose firms have relocated to the suburbs and simply people who choose to live in the city but work in the suburbs.

The third market is intrasuburb and comprises travel within towns, typically for shopping, personal business or social reasons. This type of travel occurs all day long. Users of transit service in this transportation market would typically be elderly people and others who cannot drive or choose not to drive for midday errands and the like.

This study considers the potential for expanded transit service for each of these markets in both the short term and the long term. Before we reach that point, though, we must first discuss the elements of suburban public transportation. The first section of the study discusses the variety of environments which make up "the suburbs" and some of the reasons why they have developed as they have. The second section discusses public transportation in more detail, considering the various types of transit services and the environments in which they are successful. After that the factors people consider in choosing their transportation mode are analyzed. An overview of the Boston region's experience with suburban transit is then presented. Finally, the study assesses the potential impact of expanded transit service in the suburbs and discusses changes in policy which would make suburban transit more viable in the long term.

THE SUBURBS

Land Use Patterns

In common usage, the term "suburb" refers to a place near to and related to a city, but with a lower density of development. This "definition" actually covers a wide range of places with diverse development patterns and histories. Especially in a mature area such as the Boston region, there is no single, archetypal "suburb," but rather a collection of many different cities and towns which together form a continuum stretching from urban to rural.

From the seventeenth century on, Boston has been the center of economic activity in eastern Massachusetts. At the same time, a number of other cities and towns developed, including Waltham, Lynn, Lowell, Framingham, Concord and others. These places were connected to Boston, but not in the relationship of suburb to city. Rather they were cities and towns in their own right, with their own economic base. Much of the rest of the region, up until the twentieth century, was primarily rural. To the extent that there were suburbs, they were located very close to the city, and in some cases were absorbed into that city (for example, several neighborhoods of Boston).

In this century, growth in population and commerce and dramatic improvement in transportation technology have led to the concept of a broad metropolitan area. Rural areas were converted into bedroom communities for the growing cities. Places that used to be separated by hours of travel are now only minutes apart. Although cities and towns remain individual entities to this day, they are much more interconnected than in the past. Membership in the metropolitan area implies a relationship to the center city of the nature of suburb to city. Thus, almost all the cities and towns of eastern Massachusetts are now considered to be, at least partly, suburbs of Boston.

Satellite Cities

Eastern Massachusetts is home to a number of cities, each with its own history. Within a few miles of Boston, Waltham, Quincy and Lynn are examples of cities with individual industrial bases which have also become suburbs of Boston. They each have densely developed downtown areas which, though generally lacking skyscrapers, are urban in nature. They also each have radial bus transit systems that serve their downtowns: Waltham is served by the Massachusetts Bay Transportation Authority (MBTA) 550-series routes, Quincy by the MBTA 200-series routes and Lynn by the MBTA 400-series routes. These radial systems

are, by and large, updated versions of old streetcar and bus lines dating to the early part of this century.[2]

Town Centers

Most towns in New England have a town center, typically containing a town hall, a post office, retail establishments, schools and churches. A cluster of houses surrounds the center before the density drops to low levels heading outward from the center. The center itself is eminently walkable, and for those living in the nearby houses, many errands can be accomplished without a car. People living in other parts of the town often drive to the center, park, and then walk to their various destinations. The town of Lexington is, in many ways, an archetypal New England town.

Sprawl Development

In contrast to the two historical models described above, most recent development in the suburbs has been in a style usually called "sprawl." This term encompasses several development patterns all of which have two elements in common: extensive use of land and reliance on automobiles. The descriptions below concern mainly commercial development. Residential development in the sprawl style may be described as typically being separated from other land uses, built at low density (at least one-quarter or one-half acre for each dwelling unit) and located in pods of housing, each one containing several cul-de-sacs, one connection to a collector road and few or no sidewalks. Even pedestrian connections between cul-de-sacs are often nonexistent.

Strips Strip development forms along an arterial roadway. Most of the buildings in a strip development are retail establishments and restaurants, forming in clusters of mini-malls or individually. All a developer needs to create a strip is permission for a curb-cut on the arterial roadway; that is, the ability to have cars enter and exit a parking lot. This type of development tends to lead quickly to congestion on the arterial road, both because of the number of people trying to get to the various businesses, and because of the conflicting traffic movements, especially left turns across the roadway. Two examples of strip development among many in the Boston area are Needham Street/ Highland Avenue in Newton and Needham, and Route 9 in Natick and Framingham.[3]

---

[2]The systems in Quincy and Lynn were formerly operated by the Eastern Massachusetts Street Railway Company. Most Quincy routes were rerouted from Fields Corner to Quincy Center when the Red Line extension opened in 1971. These routes had always served a dual purpose of carrying commuters to Boston as well as carrying local trips in Quincy. The current MBTA routes in Lynn cover many segments of old routes, but have been reconfigured to adapt to changing travel patterns. The routes in Waltham were operated by the Middlesex and Boston Street Railway Company until 1972. Some routes have been modified since then.

[3]Many of the left-turn conflicts have been eliminated from Route 9 over the years. Nonetheless, the large amount of development in this corridor results in severe congestion.

Industrial Parks Much of the commercial and industrial development in the suburbs has taken place in industrial parks. A town might set aside a large parcel of land, usually one with good access to the regional highway system, and zone it for commercial use in order to keep commercial and industrial buildings separate from residences.[4] This parcel then becomes an industrial park, with its own internal road system. The buildings there may be a mix of offices, factories and warehouses. Some industrial parks, generally the older ones, may be austere in style, while others may be lush, landscaped campuses. In some cases, one company might build an office campus all for itself. Examples of office parks in the Boston area are the Bear Hill Industrial Park in Waltham and the Norwood Industrial Park at University Avenue in Norwood.

Malls Shopping malls have become a commonplace in American metropolitan areas. They are often built near highway interchanges and/or on the fringes of communities where opposition to rezoning could be expected to be minimal and land is inexpensive. Outdoor malls, really a type of strip development, have been in existence for decades, but indoor, or enclosed, malls have proliferated in the past twenty years or so. With a few large department stores as anchors, many specialty shops in between, a food court and often a multiplex movie theater, malls have replaced town centers as the main gathering place of suburban life. Suburban malls inevitably have a huge parking supply, gauged to the peak holiday shopping season. Examples of large malls in the Boston area include the North Shore Mall in Peabody, the South Shore Plaza in Braintree, the Natick Mall and the Burlington Mall.

Reasons for Development

Having described the various types of development in the broad range of cities and towns considered to be suburbs, we are left with the question of why this development has occurred. After all, prior to 1950, most large companies and retail stores were located in the cities.

Part of the answer is that jobs followed the labor force. The start of suburban industrial/office park and mall development followed closely on the heels of the post-war suburban housing boom. GIs returning from the Second World War to start families needed places to live, and suburban ranch house developments were one response.

More specifically, though, a number of factors worked together to make suburban areas more attractive than older cities for new development. Perhaps the most important factor was that land in the suburbs (other than in the already developed parts of satellite cities) was cheap, available and easy to develop. The

[4]Alternatively, a real estate developer might purchase open tracts of land along a highway and then persuade municipalities to zone it for commercial purposes.

buildings that went up in the suburbs were more spacious and had lower rents than buildings in the city. Also, reasons for locating in the city have become less important over time: for example, while it is useful for a factory to be near a port facility, there is no reason why a software company needs to be. Being close to other firms has also become less necessary with the advent of overnight mail, fax machines and electronic communication. Furthermore, growth in trucking freed industries from reliance on freight railroads; a factory or warehouse could be located anywhere a truck could reach.

With the construction of the regional highway network, the land that had always been cheap and available suddenly became accessible as well. Until suburban highways became congested, access to suburban workplaces was even better than access to the urban core, provided that one had a car.

At the same time that it was attractive for developers to build in the suburbs and for firms to locate in the suburbs, it was also attractive for suburban cities and towns to encourage development. Most local finance is based on the property tax, and the amount of money a town can levy depends on two factors, the tax rate and the tax base, that is, the property to be taxed. The bigger the tax base, the lower the town can set its tax rate, and a low tax rate is always more popular than a high one.

This calculus has become crucially important since 1980 when Massachusetts Proposition 2 $^1/_2$ was passed by referendum. This law limits the amount of money a city or town can collect by stating that the total property tax revenue in a given year may not be more than 2.5% greater than the previous year's total. The law also sets an absolute maximum levy of 2.5% of the total cash valuation of the property in the city or town. The only way to boost revenue above these limits, besides a referendum override, is by increasing the tax base through new development. Both commercial and residential development increase the tax base, but the former has, in many cases, been strongly favored. Commercial development is a more efficient generator of revenue, because for a given parcel of land, an office building will generally have a higher assessed valuation than a private home. Residential development, furthermore, produces higher expenses, as it increases the demand for local services. Families with children need schools, and retirees often need special services.

To this day, many towns are eager for new development to help relieve fiscal pressures. A town that is eager is not going to impose restrictions on how a particular parcel is developed. Sprawl development is the result, since it is usually the least expensive way to develop, at least in the short run.

PUBLIC TRANSPORTATION

The term "public transportation" or "transit" encompasses many types of services both publicly and privately operated. The broadest division of these services would be into two categories: fixed-route and demand-responsive. The vast majority of person-trips taken on public transportation are on fixed-route services, such as buses, subways, ferries and commuter rail. Demand-responsive services are more expensive to operate and therefore are usually reserved for particular needs; the MBTA's "The RIDE" for people with disabilities is an example. Bridging these two categories are shuttle services operated by employers, housing complexes or other organizations. These shuttles may run on a fixed route and schedule but might also be available for special trips.

Fixed-Route

Most of the fixed-route service in the Boston region is operated by the MBTA, but private carrier routes and smaller bus systems operated by cities, towns and transportation management associations also fit into this category. Different types of service are appropriate for different types of areas: while six-car trains running on five-minute headways are necessary for rush hour on the Orange Line, one twenty-passenger bus running hourly may be all that is needed to satisfy the demand in a suburban area. The primary determinant when it comes to the appropriate level of service is *density.*

Many studies have included figures on the development density needed to support fixed-route transit. Of course, since the level of transit service can be anywhere on the continuum just described, the critical density can vary just as much. The Institute of Transportation Engineers, in *A Toolbox for Alleviating Traffic Congestion* (1989), recommended the minimum densities for various types of service shown below in Table 1.

Density is so important because a fixed-route service has a limited service area. It is limited because people (1) don't like to walk and (2) don't like to transfer. For most bus services, the maximum tolerable walking distance for most of the potential riders is one-quarter mile. Rail services, because they operate at higher speeds and provide a direct connection to the downtown area, can draw walk-in patrons from somewhat longer distances. Driving or bicycling to a transit service is an option for some people, although relatively few people exercise that option for local bus service, and for drive or bike access to be attractive for rail and express bus services, good roadway access and adequate parking facilities are necessary.

Table 1
Minimum Densities to Support Fixed-Route Transit Service

Service	Residential Density	Size of Employment Center[5]
1 bus/hour	4 to 6 dwelling units/acre	20,000 to 32,000 employees
1 bus/30 minutes	7 to 8 dwelling units/acre	32,000 to 80,000 employees
1 bus/10 minutes	15 dwelling units/acre	80,000 to 200,000 employees

Transfers are a major deterrent to transit use, because they usually involve a walk between vehicles, sometimes a second fare, and an indeterminate amount of waiting time. One study has shown that a transfer, as a factor influencing a traveler's choice of mode, is equivalent to fifteen minutes of added travel time.[6]

Given that a specific route has a limited service area, the number of people that service will carry is limited by the number of origins and destinations within its service area. The more densely developed the land within the service area is, the greater the potential ridership on the service.

While the appropriate level of service is dependent on the density, the ridership level attained is dependent on the level of service. People are much more likely to ride a high-frequency service than one that runs once per hour. With a high-frequency service, people can reasonably expect a short wait time and have the flexibility to travel whenever they want. Low-frequency service greatly restricts possible departure times and also creates anxiety because if one misses the bus, it is going to be a long wait for the next one.

In a low-density area, there are simply not enough potential trips to support a high-frequency service; that is, were a high-frequency service to be put on the street, each trip would carry only a few riders and most of the seats would be empty. Consequently, the operating cost per rider would be very high. A low-frequency service would be more economically feasible, but most of the potential ridership would not find this service attractive as an alternative to driving or using some other mode. Thus, the ridership would be lower and would consist almost entirely of people who have no other travel option.

[5]The figures in the ITE report were the square footage of floor space of commercial and office establishments. For consistency with other parts of this report, the floor space amounts have been converted to the number of employees, assuming one employee per 250 square feet of office space.
[6]CTPS for the Federal Transit Administration, *Transfer Penalties in Urban Mode Choice Modeling*, January 1997.

Density in itself does not tell the whole story, though. The most successful transit systems operate in places that are also *good walking environments.* Walking is a part of almost every transit trip, on the access end, on the egress end, or both. Most people want their walk trip to be safe and interesting in addition to being as short as possible. Safety entails being separated from the dangers of heavy traffic as well as personal security—having many other people around, and well-lit and well-maintained streets and sidewalks. Interest also involves having other people around, in addition to having shop windows to look at, places to stop for coffee, and perhaps a few trees as well.

A third important characteristic of a transit-friendly environment is *a mix of land uses.* Many trips are actually trip chains—a series of trip purposes linked together, such as stopping at the daycare center, the bank, the dry cleaner and the coffee shop on the way to work. If there is a mix of land uses, people can accomplish trip chains on foot and thus will be more likely to take transit. If these places are separated by more than a few blocks, let alone a few miles, it would be very inconvenient to accomplish the trip chain without a car.

High-frequency, fixed-route transit service is practical in very specific circumstances. In areas that do not have the requisite density, do not provide a suitable walking environment and do not have a mix of land uses, transit service will not be attractive to people with other options and so will carry primarily the transit-dependent.

Demand-Responsive

Demand-responsive transit service is not mass transit; rather, it serves at most a few people at a time. It is more flexible than fixed-route service in terms of routing and departure time, usually providing door-to-door service. There is a catch, though, in that it is more expensive to operate, especially if the provider is required to respond to all requests for service.

One can find many demand-responsive vehicles at airports or other transportation hubs for carrying passengers to and from hotels, convention centers or major employers. A large apartment complex may retain a van service to carry residents to a transit station or a mall. These types of services are offered as a courtesy to clients, customers or residents, and there is usually not a guarantee of service. However, the provider often can develop a good sense of the patterns of demand and gauge capacity to meet that demand. Taxicabs are a form of demand-responsive transit but are usually treated separately because they are not operated by transit agencies, nor are they designated for special purposes as are the services described above.

In the Boston area, the largest demand-responsive service is The RIDE, a paratransit (i.e., complementary to the fixed-route transit system) service for people with disabilities, operated under contract to the MBTA. In a typical

month, the MBTA will receive more than 120,000 requests for trips on The RIDE, and the number can be highly variable on a day-to-day basis. Because the MBTA does not have the option to refuse a large number of requests (normally less than 3% of trips are deemed "not available"), it must maintain the capacity to serve peaks in the flow of requests.

To improve efficiency in scheduling and increase occupancy of its RIDE vans, the MBTA encourages RIDE patrons to schedule their trips at least twenty-four hours in advance. In spite of this effort, the operating cost per person-trip on The RIDE is upwards of $20. Because it is so expensive to operate, The RIDE service is reserved for people who are unable to use other forms of transportation.

Shuttle Services

There are many shuttle services in the Boston region, both in the urban core and in the suburbs. A wide range of organizations consider it useful to provide such services, including employers, colleges, hospitals, shopping malls, housing complexes, etc. Most of these services are intended for a particular group of people rather than the public in general, and thus are not truly public transportation. Some allow other riders to use the service, although they might be charged a fare, while the intended group generally rides free.

Vehicles on these shuttle routes typically run on a fixed-route and schedule, but these services are very different from the fixed-route services described above. When the riders in a van are all employees of a certain company, the company can schedule that van at the time most mutually convenient for the employees and the company. The schedule is essentially fixed, because the demand does not change much from day to day, but service can be adjusted at will. In contrast, a public transit agency rarely serves such a narrowly defined population, and thus has less flexibility to alter schedules to conform to the riders' needs.

Shuttle services can also be more like demand-responsive services in certain circumstances. For instance, during the peak shopping season, a mall may run shuttles from a transit station and instruct drivers to leave as soon as there is an adequate load, rather than waiting for a particular time as might be the policy at other times of year. In the case of an employer shuttle, if the van happens to be idle during the midday and an employee urgently needs a ride somewhere, the employer could make the van available to respond to that need.

FACTORS AFFECTING MODE CHOICE

Why do some people choose to drive while others choose to use transit? Considering the answer to this question is essential in finding ways to successfully expand transit service in suburban areas. Of course, this question presupposes that people can choose their mode of travel, which is untrue for a significant portion of the population. For the purposes of this section of this paper, though, we will only consider those who do have a choice.

Convenience

If you ask commuters why they use the mode they do, the most common answer will be "convenience." Survey after survey has returned this finding. A 1995 survey of eastern Massachusetts commuters conducted for CARAVAN for Commuters showed that convenience was the number one advantage of the respondents' primary mode of transportation, no matter which mode they used—drive alone, transit or carpool/vanpool. A 1997 survey of participants in five transportation management associations in the Boston area produced the same result. Finally, the systemwide on-board passenger survey conducted for the MBTA from 1993 to 1995 showed that 78% of commuter rail users, 69% of rapid transit/light rail users and 46% of bus users cited convenience as a reason that they used MBTA services. For each transit mode, convenience was the most common reason cited.

The term "convenient" can mean different things to different people. Some of the phrases various travelers might substitute for "convenient" are "it makes my commute quick and easy to accomplish," "hassle-free," "flexibility to come and go when I am ready," "don't have to walk very far, especially in bad weather," "allows me to run some errands on the way," or "don't have to worry about it." Some of these phrases are more applicable to some modes of travel than to others, but many of them could be true of any mode.

From a transportation planner's perspective, convenience boils down to two concepts: access/egress time and flexibility. The first of these concepts concerns the amount of time it takes to get from the origin location (for discussion purposes, the home) to the primary transportation mode—that is, the mode used for the majority of the trip—and then the time from the primary transportation mode to the destination location (say, the workplace). If the trip (from home to work) involves more than one transportation mode, for instance, automobile and commuter rail, or bus and rapid transit, the mode used for the lesser portion of the trip would normally be included in the access or egress portion of that trip.

In general, a convenient mode of travel is one that involves a minimal amount of access and egress time. If there is a bus stop right in front of your house, that is convenient. If your workplace is across the street from a commuter rail station,

that is convenient. If your workplace has a parking garage and you know you have a space waiting for you, that is convenient. Inconvenience means that you have to travel some distance to catch the bus or the train, or that the bus drops you off a twenty-minute walk from your office, or that your building has no parking and you have to walk a quarter-mile from the nearest lot.

A trip by automobile from home to work is almost always extremely convenient on the access end (unless you live in downtown Boston and can't park near your home), and usually convenient on the egress end (again with the exception of some dense urban areas in Boston and Cambridge—except for those people with the privilege of reserved parking spaces). A trip by transit is convenient only if one lives near a transit line (whichever mode) or has an easy drive-access trip to the transit line, and if that transit line serves one's destination in a reasonably direct manner (without too many transfers or reverse moves). Such is true for many of the current MBTA riders, as is reflected in their frequent citation of the convenience of MBTA service. Carpools and vanpools can offer the convenience of door-to-door service, but sometimes at the price of making the overall trip longer. Carpools or vanpools that form at a park-and-ride lot or drop passengers off downtown at a central location are less convenient.

It is important to remember that for a mode to be convenient, it must be convenient on *both the access and egress ends.* For commuting trips to suburban locations, the chance that a transit trip will be convenient is very small, whereas it is very likely, given the abundance of parking in most suburban areas, that an automobile trip will have convenient access and egress.

The second major component of convenience is flexibility. This term involves flexibility of departure time,[7] flexibility to respond to urgent situations, flexibility to vary one's route and flexibility to make stops on the way. *A convenient mode is one that is there when you need it and will take you where you want to go.* To most people, this sentence describes an automobile. Transit is convenient in this way only for people who spend much of their time in a densely urbanized area surrounded by several high-frequency transit services going in all directions. In such an area, transit may be much more convenient than an automobile because finding a nearby parking space can be very difficult. Carpools and vanpools are inferior to automobiles in terms of flexibility; the schedules of several people are involved and often cannot be changed on short notice. Carpoolers will sometimes rely on the transit system as a backup if an emergency arises.

[7]This type of flexibility is closely related to access and egress time, because waiting at a bus stop or a train station could easily be thought of as part of the access time, that is, the time from when one leaves the origin location to when one boards a transit vehicle. As discussed below, both access/egress time and waiting time are part of "out-of-vehicle" time.

Cost

While convenience may be the single most important factor affecting mode choice, cost also figures prominently, particularly for transit users. Cost is rarely cited as a reason for choosing to drive, but it is often cited as a reason for using transit or carpooling. Indeed, in the MBTA systemwide passenger survey, 42% of rapid transit users and 45% of commuter rail users identified parking cost (or overall cost) as a reason why they ride the MBTA. These percentages were second only to "convenience" in the list of possible reasons.

Setting aside the cost of parking for a moment, the out-of-pocket travel costs for people who commute short-to-moderate distances (up to fifteen miles each way) are relatively low whether one drives, carpools or takes transit. For automobile use, the only relevant out-of-pocket costs are gasoline and tolls.[8] Gasoline prices are at historic lows in inflation-adjusted terms, and most roads in the region do not have tolls. Of course, owning an automobile in the first place can be prohibitively expensive for some people; available transit service can allow someone to forego that cost. However, once one makes the investment in a car, the perceived cost to use it is low. For transit, the only cost (other than parking cost at a park-and-ride lot) is the fare, and fares on the MBTA system are very low by national standards. Furthermore, many regular riders use monthly passes or discounted tickets, reducing the perceived daily out-of-pocket cost.

Given that travel costs are relatively low, parking cost is usually more important. That is to say, *a high parking cost at a trip destination can be the key factor causing someone to carpool or use transit instead of driving.* Parking in an urban area can be very costly, upwards of $20 per day in some parts of Boston and Cambridge. In contrast, parking at locations outside of Boston and Cambridge is mostly free; employee parking at suburban workplaces is virtually always free. Parking costs for carpools or transit are low or nonexistent; only Alewife station at the northern end of the Red Line has a "high" parking cost, at $4 per day, and it fills to capacity nonetheless.[9]

Time

Travel time is another major factor affecting mode choice. It is usually a reason cited by automobile users for why they drive, but some transit users, particularly commuter rail riders, cite travel time as an advantage of transit. Transit ridership is highest in those corridors where transit has a travel time advantage over

---

[8]Other engine fluids, tires, brakes, etc. require expenditure infrequently and thus are usually not perceived to be part of regular operating cost. Insurance and other costs are not mileage-related, for the most part, and thus are not associated with day-to-day use.

[9]Parking garages for the Red Line stations in Quincy and Braintree also have relatively high parking fees compared to the rest of the system, at $2.50 per day, and they also regularly fill to capacity.

automobiles.[10] Thus, many of the people who choose to take transit are those for whom it is faster than driving.

Carpoolers and vanpoolers also frequently cite travel time as an advantage of their mode. Such an advantage is most common in corridors with reserved facilities for high-occupancy vehicles, or HOVs. In the Boston area, Interstate 93 has two HOV facilities, a two-mile HOV lane north of the downtown area and the six-mile "zipper lane" south of downtown from Freeport Street in Dorchester to the Braintree split.

Travel time has two components: in-vehicle time and out-of-vehicle time. In-vehicle time is the time spent literally inside a vehicle, whether it is a car, van, bus or train. Out-of-vehicle time includes access and egress time and any time spent waiting for a vehicle to arrive. It is thus closely related to the concept of convenience, discussed above. The importance that people place on convenience is reflected in transportation mode choice models, which typically assume, based on observations of behavior, that people give out-of-vehicle time anywhere from 1.5 to 4.0 times the value of in-vehicle time; that is, ten minutes waiting for the bus is worth from fifteen to forty minutes of travel time inside the bus.

Reliability

People especially hate waiting if they do not know how long they will have to wait. To the extent that a transit vehicle or vanpool departs *reliably* at a certain time, people can minimize their waiting time by scheduling their arrival at the departure point to be close to that departure time. However, if the actual departure time varies from the scheduled departure time, people have to allow extra time for that variability, guaranteeing that they will have to wait at least some length of time on most days. On those days when the transit vehicle or vanpool is late, the anxiety and frustration felt by the rider is aggravated to the extent that the degree of delay is unknown.

Of course, reliability concerns more than just departure time; the in-vehicle portion of the travel time is also subject to variability. For road vehicles, the variability is due mainly to traffic conditions which change on a day-to-day basis and can vary significantly depending on the weather, holiday-related traffic, or the occurrence of any breakdowns and accidents. Buses and carpools/vanpools are subject to this same variability, although HOV facilities allow the vehicles using them to bypass some of the worst congestion.

---

[10]The Attleboro line has by far the highest ridership in the commuter rail system. Not coincidentally, it has the fastest average speeds. In contrast, driving times to Boston from the southwest are comparatively long because there is no direct route into the city from that direction.

Transit vehicles in dedicated rights-of-way can have better in-vehicle time reliability than road vehicles, assuming that all parts of the system are functioning smoothly. Here, too, though, signal and switch failures and vehicle breakdowns can cause significant delays.

Other Factors

Several other factors can affect a person's choice of travel mode, with the relative importance of these factors differing from person to person. These would include comfort, safety, the ability to use commuting time productively, environmental considerations and social reasons. Some of these factors work to the advantage of automobiles while others work to the advantage of transit or carpools/vanpools.

An individual's perception of how the various modes "score" on these measures and all the ones described above tends to be durable. In other words, once a person has formed an opinion, it can be difficult to change that person's mind. The opinion may be based on a few personal experiences (or even one bad experience), or on what friends, colleagues or the media say about a particular mode. Transportation models assume that people are rational decision-makers. In reality, some people may cling to some particular mode or route even if it makes sense to switch.

THE BOSTON REGION'S EXPERIENCE WITH SUBURBAN PUBLIC TRANSPORTATION

As indicated in earlier sections of this paper, the Boston region's suburbs represent a wide variety of environments and development styles. Accordingly, there is a wide variety of public transportation services being operated in suburban cities and towns. Some of these services are operated by the MBTA, while others are town operated. In addition, there are numerous shuttle services offered by employers, schools and transportation management associations.

The MBTA in the Suburbs

Existing MBTA service in the suburbs is generally located in the more populous and densely developed suburbs and nearby cities, such as Quincy, Medford, Watertown, Waltham and Lynn. Most of these services have a historical basis, in that those routes were instituted by private operators when fewer trips were made by car and when there was a greater focus on travel to those town centers. As the geographical reach of Boston has grown, these routes have been updated to provide connections to the rapid transit, commuter rail or express bus systems so that they also serve core-oriented trips. The trips made by downtown-Boston-bound riders on these local suburban routes helps to support a higher level of service that benefits the much smaller suburban transit market. These services also provide opportunities for reverse commutes, made by residents of the urban core who work in the suburbs, to such work destinations as Hanscom Air Force Base, the V.A. hospitals in Bedford and West Roxbury, and industrial areas and shopping malls in Burlington, Woburn, Peabody and other places.

Local Suburban Services

In the mid-1970s, the MBTA launched a program to subsidize suburban bus systems. The intention of the program was to support public transportation in outlying areas, allowing cities and towns to design systems appropriate to their needs. The program continues to this day, with eleven systems currently operating. The ridership on these systems is shown below in Table 2.

Appendix A of this report is a memorandum written by Thomas J. Humphrey of CTPS in March 1993 as part of the background material for the 1994 Program for Mass Transportation. This memorandum provides a history of the MBTA Suburban Transportation Program through 1992 and briefly discusses each of the suburban systems. It also contains some information on non-MBTA-subsidized suburban bus systems, including those in Sudbury, Newton and Concord.

The Newton service mentioned in Appendix A was discontinued, but the city began a new local service, called Nexus, in June of 1997. This service originally consisted of three loop routes for the morning and afternoon peak periods and

three loop routes for midday periods. The service pattern was revised in May of 1998 to consolidate the routes into two large loops. The northern loop has hourly service in both the clockwise and counterclockwise directions, while the southern loop has only counterclockwise service (also hourly). The Nexus service operates Monday through Friday, with the first departures at 6:30 a.m. and the final arrivals at 7:25 p.m.

Table 2
Local Transit Systems Supported by the
MBTA Suburban Transportation Program

Suburban System	Average Boardings per Day	Average Boardings per Trip
Bedford (Bedford Local Transit)	24.8	DR*
Beverly (Beverly Shoppers Shuttle)	120.3	12.0
Burlington (B Line)	264.0	4.3
Dedham (Dedham Bus)	102.7	5.1
Framingham (LIFT Bus)	388.0	12.8
Lexington (LEXPRESS)	288.0	4.4
Lynn (Lynn Loop Bus)	48.5	4.0
Mission Hill (Link)	213.5	6.7
Natick (Natick Neighborhood Bus)	172.6	10.7
Needham (taxi service)	13.7	DR
Norwood (taxi service)	16.1	DR

*DR = demand-responsive

JBL Bus Lines currently operates one unsubsidized suburban route between Braintree and South Weymouth. Parts of this route overlap with former MBTA Route 252 and parts of Weymouth's Weybus local system (see Appendix A).

The Cape Ann Transportation Authority operates several local bus routes, including four routes in Gloucester and three routes connecting Gloucester to Rockport. Additionally, it operates weekly service between Cape Ann and the Peabody/Danvers area.

At the time of this writing, the city of Waltham was about to approve the implementation of three local routes in Waltham. This service was designed in cooperation with the 128 Business Council and will be operated under the aegis of that organization. Two of the routes are extensions of existing shuttle routes operated by the 128 Council (see below), and the third is a new route operating on Lexington Street between Waltham Central Square and the employment centers in the northwestern part of the city.

TMA/Employer Shuttles

The 128 Business Council is one example of a transportation management association, or TMA. A TMA is a "private non-profit group formed to facilitate private sector involvement in addressing transportation issues."[11] TMAs are supported by a group of corporations in a specific geographical area and, in many cases, also receive financial assistance from the state highway department for up to three years. TMAs exist in both urban and suburban settings.

While TMAs are involved in a number of activities, several operate shuttle services connecting employers to transit stations. These services are mainly intended to serve employees of member corporations but will also carry other passengers. Table 3 below lists the suburban TMA shuttles in the Boston area and includes the average number of boardings per trip.[12]

Table 3
Suburban TMA Shuttles in Boston Region

TMA	Route	Boardings/ Trip
MetroWest	Railink 4 - Natick station to Speen St./malls	5.0
Neponset Valley	Railink 1 - Quincy Adams station to Canton	5.0
Neponset Valley	Railink 2 - 128 sta. to Dedham Corp. Ctr. sta. via University Ave.	5.2
128 Council	Alewife station to Waltham and Lexington	10.4
128 Council	Riverside station to Waltham	1.8

The ridership on these shuttles is highly dependent on the cooperation of the TMA's member corporations and the number of potential destinations along the shuttle route. For example, the Neponset Valley TMA's Railink 2 service experienced a fourfold increase in ridership from October 1997 to April 1998 when several new companies began participating in the service. The 128 Council's Alewife shuttle is the most successful of this group because it not only serves several employers in Waltham and Lexington but also carries passengers from Windsor Village, a large housing complex in Lexington, to Alewife in the morning and home in the evening. Having travel demand in both directions greatly improves the cost-efficiency of the service.

The annual cost of operating a shuttle service ranges from $60,000 to $80,000 per vehicle. In some cases, employees of member companies ride for free, but in other cases they are required to pay a fare.

[11] *Commuter Transportation Resource Guide,* published by CARAVAN for Commuters, Inc., 1998.
[12] Ridership figures are from Spring 1998

Some employers choose to operate their own shuttle services, either because they are not located in a TMA-served area or because they wish to have the maximum flexibility to tailor the service to their needs. Other employers operate shuttles because the city or town in which their office park is located required them to as part of the building permit process. Employer shuttles are usually not open to the public and usually charge no fare. A partial list of suburban employer shuttles is given below in Table 4. There is little information available about their ridership or operating cost.

Table 4
Suburban Employer Shuttles

Employer	Route(s)
A. D. Little	Alewife station to Cambridge
Abt Assoc.	Alewife station to Cambridge
Anderson Consulting	Riverside station to Wellesley
Bay Colony	Waltham station to Waltham
Fidelity	Riverside station to Marlborough
GTE	Alewife station to Cambridge
Lotus and others	From Mishawum station
Presidents Landing	Wellington station to Medford
PSDI Inc.	Alewife station to Bedford
State Street Bank	N. Quincy station to N. Quincy; Ashmont station to Westwood
Unknown	From Mansfield station

School Shuttles

Several colleges located in suburban areas offer shuttles that connect to the MBTA rail system or in some cases operate directly to Boston or Cambridge. The majority of those shown in Table 5 below connect to the D (Riverside) branch of the Green Line. All of these shuttles are intended primarily for students but may also carry other members of the college community.

Table 5
Suburban College/School Shuttles

College/School	Operates to/from:
Babson College (Wellesley)	Woodland station
Bentley College (Waltham)	Harvard Sq. (nights/weekends only)
Boston College (Newton)	Reservoir/Cleveland Circle station
Cambridge School (Weston)	Riverside station
Lasell College (Newton)	Riverside station
Mass. Bay Community College (Wellesley)	Riverside station
Mount Ida College (Newton)	Newton Centre station
Newbury College (Brookline)	Reservoir station
Pine Manor College (Brookline)	Chestnut Hill station
Regis College (Weston)	Riverside station
Rivers School (Weston)	Riverside station
Wellesley College	MIT (weekdays)
Wellesley College Senate Bus	MIT/Harvard Sq./Woodland station (weekends)
Wheaton College (Norton)	Mansfield station/Attleboro station

POTENTIAL EXPANSION OF TRANSIT IN THE SUBURBS

How can transit service in suburban areas be best expanded? The above discussions of suburbs, public transportation and the factors affecting mode choice should make it clear that there is no one simple answer to this question. The variety of environments that make up "the suburbs" and the variety of possible transit services mean that each candidate area must be considered individually in order to find the most appropriate solution.

Such consideration is beyond the scope of this paper. However, the overall suburban travel market can be divided into three segments: suburb-to-suburb, city-to-suburb, and intrasuburb. Certain types of transit service will be more appropriate than others for each of the market segments. By laying out these fundamentals, this paper can serve as a starting point for future, more focused studies to determine the feasibility of specific transit services in specific areas.

Suburb-to-Suburb Travel

Nearly 700,000, or approximately 40% of the 1.7 million daily work trips in the Boston metropolitan region, can be classified as suburb-to-suburb.[13] This figure does not include work trips that do not cross town boundaries, which would be classified as intrasuburb and will be discussed below. Much of the peak-period congestion problem experienced in suburban areas is due to suburb-to-suburb work trips.

Of course, there is a great deal of travel in the suburbs for purposes other than work, even during rush hour. Nonetheless, the work trip will be the focus of this analysis, because the daily commuting trip is more likely to be susceptible to a transit solution than nonrepetitive shopping, personal business or recreational trips.

Requirements for Success

The only type of transit service that would be economically feasible to operate and would potentially have an impact on congestion would be some type of fixed-route service. The most likely candidate would be an express bus service.[14] A scenario in which such service would be successful would have the following characteristics:

---

[13]The total number of work trips in the Boston region in 1990 was 1.722 million. Excluding trips which did not cross any town boundaries (530,000), and excluding trips to or from Boston and Cambridge (500,000) yields the 692,000 suburb-to-suburb trips.

[14]Carpools and vanpools are sometimes viewed as "precursors" to an express bus service. Since they are not public transportation, they will not be discussed explicitly here, but most of the following discussion applies to them as well. In fact, carpools and vanpools would have a greater chance of being successful than a traditional fixed-route transit service.

- Large number of jobs in an employment center
- Dense travel corridor
- Park-and-ride facilities with easy access from road network
- Sufficient distribution mechanisms
- Some advantage over driving alone

For a fixed-route transit service to be feasible at all, there must be a concentration of employment. The smaller the geographic area and the greater the number of jobs (that is, the higher the density), the better.

A dense travel corridor is one that has many trips traveling along a similar path toward the job center. Such a corridor would typically form along a major highway leading to the job center, especially if the cities and towns along that highway were well populated. To the extent that there are many people traveling a significant distance on the same road, there would be an opportunity for an express bus service.

In order to collect passengers for an express bus service, there must be park-and-ride facilities located in the travel corridor. In almost all cases, the origin locations for travelers in the corridor will be too dispersed to allow a bus to pick people up near their homes and still accomplish the trip in a reasonable amount of time. Thus, drive access for most or all of the passengers will be necessary. The park-and-ride facilities must be located far enough away from the job center that the time spent on the bus (the in-vehicle time) is significantly greater than the access time (part of the out-of-vehicle time), because otherwise there would be little perceived benefit in using the bus rather than driving all the way to work.

Given that there is no suburban job center in the region where there are many jobs concentrated in a very small (walkable) area, there would have to be distribution mechanisms in place so that passengers could get to their destinations quickly.[15] The distribution mechanisms could be coordinated with, or, in fact, be the same as those serving city-to-suburb trips, discussed in detail below. Such coordination implies that the express bus would terminate at a rail transit station, since that is where city-to-suburb passengers would be arriving. This would allow the express bus to have a second function as a feeder to the core-focused rail system, assuming that schedules could be arranged to allow for convenient transfers.

The final requirement is perhaps the most difficult. Transit service could be put on the street that is reasonably fast, comfortable and reliable. However, unless it has some advantage over driving, few will use it. There are currently no HOV facilities

[15]The express bus could be sent on a loop through a job center, thus avoiding the need for riders to transfer to a distribution vehicle. However, in a job center of moderate to low density, the amount of time it would take to reach the front doors of a significant number of employers would make the transit service less attractive overall.

in suburban areas, and thus the bus would not have a travel time advantage over a car; in fact, a trip involving the bus would almost certainly be longer than a drive-alone trip. Unless there is some cost associated with an employee parking at the workplace or some significant financial incentive offered by employers to encourage employees to take transit, the bus would not have a cost advantage over a car, even if the bus fare were subsidized. A trip by bus will almost always be less convenient, given the need for motorized access and egress trips for most riders. The only real advantage the transit service would have for the individual commuter is that it would allow him or her to relax or use the commuting time productively.

Potential Corridors

Although the above discussion would lead one to think that it is unlikely that an express bus service to a suburban job center would be successful, analysis of commuting flow data from the 1990 U.S. Census indicates that further study may be fruitful in certain areas.[16] Eight suburban "clusters"—groups of between two and five cities and towns—were selected for analysis, including all of those suburbs with the greatest numbers of jobs. These clusters are shown in Table 6 below with their total 1990 employment, land area and jobs per square mile.

Table 6
Suburban Employment Clusters

Suburban Cluster	1990 Employment	Land Area (sq. mi.)	Jobs per Square Mile
Beverly/Danvers/Lynn/Peabody/Salem	109,959	63.7	1,726
Bedford/Lexington/Waltham	103,935	42.6	2,440
Burlington/Wilmington/Woburn	81,713	41.8	1,955
Needham/Newton/Wellesley	77,045	40.5	1,902
Braintree/Quincy	66,685	30.2	2,208
Canton/Dedham/Norwood/Westwood	62,092	51.1	1,215
Framingham/Natick	54,120	38.8	1,395
Hudson/Marlborough	34,874	32.7	1,066

The total employment figures shown in the table above are quite high, but the employment *density* figures are not, ranging from 1,066 jobs per square mile for Hudson/Marlborough to 2,440 jobs per square mile for Bedford/Lexington/Waltham. For comparison: the city of Boston as a whole has 12,451 jobs per square mile and downtown Boston (the peninsula north and east of Massachusetts Avenue) has more than 120,000 jobs per square mile. The

[16]The decennial census is the only available source for commuting data on a regional basis. Although the data are now eight years old, they are suitable for the purposes of this paper since we are considering commuting patterns only at the broadest level. Future studies focused on specific areas could make use of employer-based surveys to gather up-to-date information.

Government Center and Financial District areas of downtown Boston have more than 300,000 jobs per square mile.

It is also important to note that none of these clusters would qualify as an "employment center" because each is made up of at least two entire towns. An "employment center," in terms of being a place where a distribution mechanism would either be unnecessary or involve only short (less than ten-minute) egress trips, would be at most one part of a town, or a small area straddling two towns such as the Shoppers World/Natick Mall area in Framingham and Natick. The total employment level for such an employment center would be lower than the figures for the clusters shown above, although possibly still high enough to support some kind of transit service.[17]

Despite the relatively low employment densities in the eight suburban clusters, fixed-route transit service to a cluster may be feasible if there are any dense travel corridors leading to it. Appendix B of this report contains a series of maps and tables showing the commuting flows for each of the eight suburban clusters. The maps are intended to show how commuting flows to a cluster are divided among the eight points of the compass (north, northwest, west . . .). Note that the towns in the cluster and the towns immediately surrounding the cluster are excluded from the calculations of the directional commuting flows; it was reasoned that trips from an adjoining town would be too short to be attracted to any suburb-to-suburb express transit service. The table following each map shows the actual number of 1990 commuters from each residence town traveling to each town in the cluster.

Several interesting findings are evident from the maps. First, the direction containing the city of Boston (south for Beverly/Danvers/Lynn/Peabody/Salem, southeast for Bedford/Lexington/Waltham, etc.) is always one of the most significant directions, simply because Boston has such a large population relative to other cities and towns in the region. Although this implies that there is a large potential for reverse commuting, this is not necessarily the case (see the discussion below in "City-to-Suburb Travel").

Second, some clusters exhibit an even distribution of commuters from all directions, while others show definite orientations. The Beverly/Danvers/Lynn/Peabody/Salem cluster has between 4,000 and 6,000 commuters coming from all directions (except the southeast where there is only water), the Braintree/Quincy cluster has between 2,500 and 5,000 commuters from all of the possible directions except the southeast with just under 7,000, and the Hudson Marlborough cluster has between 1,500 and 3,000 for all sectors but the west

[17]Unfortunately, fine-grained, reliable and up-to-date employment data are scarce and expensive. Thus it is difficult to pinpoint the locations of employment centers on a regional basis. Studies focused on specific areas or corridors would be more able to analyze employment centers than the present paper.

(which has 4,000). The Needham/Newton/Wellesley cluster also has significant numbers coming from all directions, although the south has noticeably more commuters than the other directions and the southwest, northwest and north have fewer.

In contrast, the Canton/Dedham/Norwood/Westwood cluster shows a clear orientation to the south and east, while the flows from the north and west are relatively small.[18] The Framingham/Natick cluster shows a large influx from the east (mostly Boston) and sizable contributions from the south and southwest. The Burlington/Wilmington/Woburn cluster attracts relatively few people from the west and northeast and many from the northwest, north and south. Finally, the Bedford/Lexington/Waltham cluster exhibits a pattern quite similar to its Burlington/Wilmington/Woburn neighbor with the northwest, north and southeast (containing Boston) the most prominent.

Of all of the many sectors shown for the various clusters, the ones which appear to be the most promising for further study are as follows:

1) Braintree/Quincy from the southeast
2) Canton/Dedham/Norwood/Westwood from the south and southwest
3) Framingham/Natick from the east
4) Needham/Newton/Wellesley from the south
5) Burlington/Wilmington/Woburn from the north and northwest
6) Bedford/Lexington/Waltham from the north and northwest

The last of these sectors has already been studied. In a 1990 CTPS report, *Commuting Patterns of Route 128 West Area Employees and Alternatives to Reduce Congestion,* the results of an employer-based survey of more than seventy companies in Waltham and two in Lexington were analyzed. The report recommended that remote park-and-ride lots be designated for commuter use and that carpools and vanpools be organized. The report identified the junction of Route 3 and Route I-495 in Chelmsford as the most promising location for a park-and-ride lot, because (1) the Route 3 corridor had the highest concentration of commuters to the study area, (2) travel times in that corridor were long because of congestion on Route 3 and (3) two parking lots were already available. The report suggested that if carpools and vanpools became popular from the remote park-and-ride lots, express bus service could then be introduced. A second recommendation was a shuttle service from Riverside station. As shown above in Table 3, this route is currently operating, having been placed into service at the end of 1995. The relatively low ridership on this route indicates that it has not yet fully exploited the potential market.

[18]Note that if Boston were included in the northeastern sector rather than being an adjacent city, that direction would have the largest number of commuters to this cluster.

Route 128 Bus

In addition to express service to suburban employment centers, another type of service which has received attention over the years is circumferential transit service on Route 128. Various services have been suggested, including a light rail line, a dedicated bus lane and a monorail above the highway median. All of these options would involve either huge capital outlays or the highly unlikely conversion of a general-purpose lane to a bus lane. Setting these options aside, it would be possible to operate a bus service on Route 128 mixing with the general traffic. Such an alternative was studied in the 1994 Program for Mass Transportation (PMT).

The analysis (which is included in this paper as Appendix C) found that a Route 128 bus could potentially generate more than 3,000 new transit trips. However, the operating costs associated with this service were found to be high. Furthermore, in order for the service to be successful, employers, TMAs and cities and towns would need to set up a series of shuttle services to distribute passengers from the Route 128 bus to the many destinations passengers would be trying to reach. The variability in travel time due to congestion on Route 128 would make it difficult, if not impossible, to assure passengers of reliable and convenient connections to the shuttle services. This Route 128 bus service was ultimately not included in the PMT as a recommended project.

Another type of Route 128 bus service that may be worthy of further examination is one that approaches Route 128 radially and then serves a portion of the corridor circumferentially. For example, a bus could start in Nashua, N.H., pick up passengers at one or two park-and-ride lots along Route 3 and then drop passengers off at two or three locations along Route 128, say the Burlington Mall and Mishawum station on the Lowell commuter rail line. Another bus could follow the same route from Nashua along Route 3, but then turn south on Route 128, dropping passengers off at Hartwell Avenue in Lexington and at Bear Hill and Prospect Hill in Waltham.

Such a radial/circumferential service could be implemented relatively cheaply on an experimental basis to test the market. The factors working against it are similar to those discussed previously: densities in suburban locations are much lower than those in urban locations, and there would be no compelling reason to ride the bus since it probably would take longer than driving and cost more in terms of out-of-pocket expense. There may be some potential riders, though, who are eager to have an alternative to driving every day.

Intertown Local Buses

Up to this point, the discussion of suburb-to-suburb travel has been limited to medium- and long-distance trips, mainly because the travel time disadvantage of transit service becomes less important at longer distances while the advantage of

using travel time productively becomes more important. The omission from the discussion of local, town-to-town service is not meant to imply that this type of service is infeasible or has no role. On the contrary, it serves a specific need.

Town-to-town local riding can be accomplished on two types of routes: (1) a route that is dedicated to this very type of trip and (2) a route that is ultimately destined for the urban core but makes local stops on the way. Two examples of dedicated local routes are LIFT 5 and 6, two of five routes in the Local Inter Framingham Transportation system.[19] LIFT 5 begins in Hopkinton and makes four stops in Ashland before making several stops in Framingham. LIFT 6 begins in Milford and has stops in Holliston and Ashland before making several stops in Framingham and Natick. Each of these routes has one morning trip and one afternoon trip suitable for commuting and four midday trips geared toward shopping or other activities.

A recent survey of LIFT passengers[20] showed that 63% of respondents from LIFT 5 and 6 were making work trips and another 14% were making shopping trips. Up to 30% of passengers used the LIFT service to connect to other transportation routes, including MBTA commuter rail, Peter Pan bus and the Natick Neighborhood bus. All age groups were represented, though 63% of respondents were between the ages of 26 and 50.

Perhaps the most important statistics yielded by the survey are those concerning income, automobile availability and reasons for using the service. Nearly half of the respondents reported incomes of less than $15,000, while only 5% reported incomes above $35,000. Again, nearly half reported owning no vehicles and another 37% reported that their household owned only one vehicle. Finally, 58% of riders stated that they used the LIFT bus because it was the only transportation available.

These findings are strong evidence that an intertown local bus will serve mainly transit-dependent people. Certainly there are some riders who choose to use the service, but because of the many stops that a local route makes, the travel time by automobile will almost always be shorter, especially for destinations near the end of the route.

The other means of town-to-town travel is to use a bus destined for the core area but which makes several stops on the way. Peter Pan operates such a bus from Worcester to Boston via Route 9 with stops in Worcester, Shrewsbury, Westborough, Southborough, Framingham, Natick, Wellesley, Newton, Brookline and Boston. The route runs three trips per weekday (in each direction)

---

[19]The route that was formerly LIFT 4 is now operated solely as a private route and is called Railink 4 (see Table 3).

[20]Conducted by the Framingham Planning and Economic Development office. Thanks to Arnold Pinsley for his statistical summaries of the survey data.

at four-hour intervals, and the fare schedule allows for trips between any two stops along the route. The extent to which this town-to-town option is used is not known. Ridership on the route as a whole is not high, at approximately 100 passengers per day.

Other private carrier routes that travel through to Boston could make more local stops and thus offer more options for suburb-to-suburb travel. However, each added stop increases the travel time and makes the service less attractive for through passengers.

City-to-Suburb Travel

As shown on the maps and tables in Appendix B, the number of people living in the urban core and working in the suburbs is not insignificant. Before one jumps to the conclusion, though, that city-to-suburb travel is a large, untapped market for transit, a limitation of the data in Appendix B must be noted. The journey-to-work figures shown in the tables are aggregated at the city and town level. Thus, for example, the 1,923 people shown commuting from Boston to Natick and Framingham are coming from the city of Boston as a whole.

While the Worcester/Framingham commuter rail line provides a direct connection from Boston to Natick and Framingham, the only places where it picks up passengers in Boston are at South Station and Back Bay station. For Natick and Framingham workers residing near those two downtown Boston stations, a commuter rail trip would be convenient, at least on the access end. However, for Natick and Framingham workers residing in other parts of Boston, it would be less convenient, especially for residents of Roslindale, Hyde Park, Mattapan and West Roxbury who would have to travel several miles northeast in order to catch a train to take them west. In sum, city-to-suburb trips on commuter rail are convenient only for people living in or near downtown Boston, and those people represent only a part, probably a small part, of the people making reverse commuting trips from the city as a whole.[21]

Limiting our consideration to those people who would have a reasonably convenient access trip to thte rail system, for employees of companies that are located in the immediate vicinity of a suburban rail station, transit can be a very viable option. Unfortunately, there are not that many companies who are located so conveniently. Many of the TMA, employer and school shuttles listed in Tables 3 through 5 are designed to bridge the gap between the rail system and suburban employers. The answer to the question of how to expand city-to-suburb transit use could be to just do more of the same.

[21]Journey-to-work data are available for areas smaller than the city and town level. Future studies focused on specific areas could consider this issue more fully than was possible here.

The growth experienced by some of the shuttle routes indicates that the market for such travel has not yet been fully exploited. The failure of some routes and the low ridership of others, though, indicate that expanding services will not necessarily be easy. A great deal of coordination and marketing is needed to achieve a successful route, and suburban employers must believe that it is a worthwhile endeavor if they are to give the routes financial support. Various TMAs and employers have shown that it is possible.

Beyond expanding the current number of shuttle routes and promoting existing ones, additional steps can be taken to increase city-to-suburb transit ridership. One possibility would be to change the fare structure on the MBTA commuter rail system to reduce or eliminate reverse-peak fares. Trains that run jam-packed into Boston in the morning rush hour turn around and run mostly empty outbound again. Since the service is running anyway and few people are using it, it would cost the MBTA relatively little to eliminate the morning peak outbound and afternoon peak inbound fares. Such a change would be particularly beneficial for inner-city residents who are moving from welfare to a job in a suburban location.

A second step would be to expand the options for egress trips from the suburban rail stations. The existing shuttles are one distribution mechanism, but there are others that are technically feasible and would make egress trips more convenient. Perhaps the best candidate is the use of station cars. These would be small electric vehicles which would be queued up at the commuter rail station in the morning (driven there by people making access trips to the station). Suburban employees could sign out these cars and drive them to their worksites, where they would be charged during the day. In the evening, they would drive them back to the commuter rail station, making them available for the Boston commuters who had used them to get to the station in the morning. Such small electric vehicles exist today, and programs like the one described here have been tested in other parts of the country. For more information, the reader can contact the National Station Car Association on the Internet at http://www.stncar.com.

As with station cars, bicycles could be provided at commuter rail stations, or the policy of allowing bikes on transit vehicles could be liberalized for off-peak-direction travel. With New England weather, bicycles would only be attractive for five or six months out of the year. Nonetheless, this is a low-cost option which could be implemented quickly.

Finally, employers that do not want to offer shuttle services could work out deals with local taxi companies and provide vouchers to their employees. Such an arrangement would be a way to test the market for reverse commuters and could lead to a new shuttle if enough employees expressed interest.

An important component of city-to-suburb transit travel, and indeed all transit travel to suburban locations, is the availability of transportation in case of an

emergency. Often known as "guaranteed ride home" programs, these services are critical to relieve the anxiety that an employee might feel at being unable to leave at a moment's notice. For the city-to-suburb commuter, there are two potential obstacles to responding to an emergency: (1) inability to get back to the commuter rail station on short notice and (2) a potential long wait for a train back to Boston. The first obstacle can be solved if the shuttle bus is idle during the day or if a station car or bicycle is used. Commuter rail schedules during the midday period do not offer frequent service, though, typically having two-hour gaps between trains. The guaranteed ride home would need to be able to get the employee all the way home, or at least to a rapid transit station which has more frequent service than commuter rail.

Intrasuburb Travel

Although congestion on the regional expressway system captures much of the much of the attention devoted to transportation issues, congestion in town centers and around shopping areas can be a source of great frustration for people trying to accomplish local trips. This traffic is usually a mix of local trips and through trips; some of the latter are on local roads to avoid traffic on the expressways.

A number of towns are looking to transit as a way to help alleviate local congestion problems. In addition, local transit services are a critical source of mobility for people who do not own cars or who cannot drive. As discussed on pages 16–17, eleven towns offer local service subsidized by the MBTA and several more offer service without state subsidy. Generally, these services are oriented toward shopping, school and personal trips, with the exception of the three intratown routes in the LIFT system, on which 60% of passengers are making work trips.

Suburban intratown services tend to be most successful when there are clearly defined travel patterns to be served. Simply running vans or buses in loops around the town will likely not attract many riders, because the various kinds of trips a loop route might serve can usually be accomplished more quickly and conveniently by car. On the other hand, if there is an origin-destination pair, such as a high-density housing area and a shopping mall, which generates a large number of trips, then a direct link by transit could attract enough riders to support at least a moderate frequency (every 30 minutes) service.

New services such as the Nexus service in Newton and the about-to-be-implemented routes in Waltham indicate that at least some suburban cities and towns are thinking actively about expanding intratown services. The impetus for new services like these ought to come from the local level, where officials are closest to the people who have need of them.

POTENTIAL IMPACT AND LONG-TERM FEASIBILITY OF EXPANDED TRANSIT SERVICE IN THE SUBURBS

Can an expansion of transit service in the suburbs reduce congestion and improve mobility? This question has both a short-term and a long-term answer, and the two answers could be the same or different depending on whether policies regarding land use, parking and taxation are changed.

Short Term

For commuting trips to almost all suburban towns in the region, the current mode share for transit services is very small. Even cities and towns with a significant amount of transit service have small transit mode shares: Quincy (7.4%), Newton (6.4%), Lynn (4.1%), Braintree (3.8%) and Waltham (2.1%). The majority of the cities and towns included in the suburban clusters discussed above have transit mode shares of under 2% or even under 1%; even if transit ridership in these places doubled or tripled, there would still be only a tiny percentage of commuters using transit.

Increased transit service in the suburbs would not result in a significant reduction in congestion in the short term. A significant expansion in service would have at most a marginal effect on traffic. For all of the reasons discussed earlier in this report, the advantages of driving in the suburbs in terms of convenience, cost, time and other factors are too great for transit services to attract a large number of riders.

On the other hand, increased transit service could have a significant positive impact on mobility in the suburbs. The growth in the number of senior citizens throughout the region and the increased need for low-income inner-city residents to be able to reach suburban jobs both argue in favor of expanded service. The expansion would no doubt require heavy subsidy, especially if the frequency of service on suburban routes were increased above minimal levels. Meeting the travel needs of senior citizens and the poor, though, would also increase mobility and transportation options for all people.

Long Term

If no changes in policy are made, the long-term outlook for transit is little different from the short-term outlook. With increased economic activity, congestion may increase, but suburban transit services, having to use the same facilities as the rest of the traffic, will still not offer significant advantages over driving.

A series of policy changes, though, could have a major impact on the feasibility of transit services in the suburbs. The fact that none of these has yet been

instituted in the Boston region indicates that there are strong forces working against them. If congestion gets bad enough, however, the impetus to change may prevail. Note that these are presented not as official goals but as changes that would be necessary for transit in the suburbs to be more successful in the future.

Land Use Policy

Current zoning codes in most cities and towns were written in the decade following the Second World War. They usually include provisions that require that land uses be separated, that a minimum number of parking spaces per thousand square feet of commercial development be constructed, that density be strictly limited, and a number of other elements.

In order to make suburban development more transit-friendly, zoning codes would need to be changed. Specifically, requirements for a minimum number of parking spaces would have to be eliminated and higher densities would have to be allowed. Developers would be encouraged to build in the immediate vicinity of rail stations and to provide attractive walking environments. Elements of "transit-oriented development" or "traditional neighborhood development" would be incorporated into the new zoning codes so that over time, people in the suburbs will not need to rely as heavily on their cars.

A second change to land use policy would be for municipalities to require developers to institute transportation mitigation measures in order to receive a permit for a new commercial development. Some towns—for instance, Wellesley, Lexington and Framingham—already have such a requirement. Some of the employer shuttles shown in Table 4 resulted from these mitigation requirements.

It must be recognized, though, that even if all local zoning codes were changed immediately, the impact of the change would not be felt for a long time. The Boston region is a mature area; the land-use pattern is well established, and the amount of new development taking place is minuscule compared to the amount that has already been built. New zoning can be overlaid on existing development, but a widespread transformation from "sprawl" to "transit-friendly" would take decades to achieve.

Parking Policy

As discussed earlier, the presence of abundant free parking in the suburbs is one of the greatest obstacles to higher transit ridership. There are three ways to change the situation, only one of which is remotely likely to occur.

The first change that could be made is simply to reduce the amount of parking available. This is not likely to happen for many reasons: there is a cost associated with digging up existing lots which no one would be willing to pay, people who

enjoy the convenience of the current spaces would be unhappy, people residing in areas surrounding reduced lots would be upset because displaced cars would likely begin to park on residential streets, merchants would be angry if there were insufficient parking for their customers, and so on.

Secondly, a regional parking fee or tax could be implemented, thus eliminating the phenomenon of free parking. Although this scheme would generate a huge amount of money which could pay for large increases in transit service, many people who are accustomed to parking for free would be upset. Universal parking charges would also involve administrative costs and some capital costs to build fences, payboards, gates and the like, but these would be more than paid for by the revenue. The fee would have to cover a wide area so that the effect of chasing development into the next town where there is no fee would be minimized. Even if the fee covered all of eastern Massachusetts, though, the fear of losing development to New Hampshire and Rhode Island would likely be enough to doom this scheme. Furthermore, in order for the parking fee to have a noticeable effect on mode choice, it would have to be on the order of $5 per day. Such a fee would be a hardship for lower-income workers, and thus there would have to be a massive increase in transit service to give people a real option to driving. If carpools and vanpools were exempted from the parking fee, there would likely be a huge increase in those modes of travel.

The third possible change, and the only one that might happen, is to require employers to offer cash to employees in lieu of free parking while at the same time making sure that there are other ways to get to work. Employers moving into new buildings where money has not already been spent to build parking spaces are the ones most likely to be receptive to this scheme. This exchange of cash for parking has been tried in various parts of the country and been found to be successful in encouraging employees to carpool or use transit.

Tax Policy

As discussed on page 6, the reliance of municipalities on the property tax and the strictures of Proposition 2 1/2 have combined to spur many cities and towns to seek to develop as much land as possible. It is really the high level of development, built in the manner of "sprawl," combined with the reliance on automobiles, rather than the automobile *per se*, that is at the root of congestion in the suburbs.

Future increases in congestion in the suburbs could be avoided if public finance were changed so that localities were less reliant on the property tax. A statewide tax—on property or on something else—could be substituted for the local property tax, with the revenue distributed by some agreed-upon formula. Regional tax base sharing would allow a group of cities and towns to focus development on the best-served area, rather than seeking it in every individual locality. They could then focus their attention on making their communities more

livable and allow only as much development as their transportation infrastructure could reasonably handle.

Other Disincentives to Driving and Incentives to Using Transit

There are ways to make driving less attractive than it currently is that have not been mentioned above, but they would all be unpopular. Large increases in fuel taxes and institution of road pricing, for example, are two ways to raise the out-of-pocket costs of driving. Converting general-purpose lanes to high-occupancy vehicle lanes would create an incentive to carpool or use transit, but it would lead to major traffic jams in the remaining lanes.[22]

[22]This statement does not cover contra-flow HOV lanes, such as the one being operated on the Southeast Expressway, which use excess capacity in the off-peak direction for additional peak-direction capacity.

CONCLUSION

Congestion problems in the suburbs go much deeper than a simple lack of transit service. The style of suburban development seen in the postwar period entails reliance on automobiles. Low densities and many-to-many trip patterns make conventional transit services infeasible. Then comes along the financial pressure to develop more and more land, and congestion becomes inevitable.

Transit has an important role providing mobility to people who cannot drive, and it also offers options to people who choose not to drive. Expansion of transit service in the suburbs would help to increase mobility; future studies which consider smaller areas in detail can help to identify the most promising locations. It is often employers, TMAs and local officials who know best what new services are needed. However, absent major changes in land use and parking policy, an increase in suburban public transportation service would likely have little or no effect on suburban congestion.

Assuming that municipalities will continue to be reliant on local property taxes for financing local goverment services, the pressure to maximize development will continue. Changes in the way new developments are built and requirements that developers and employers mitigate the impact of new offices on the transportation system can help reduce future increases in the level of suburban congestion.

Cooperation among employers, and between employers and their employees, could make transportation options other than driving more viable. The worse congestion gets, the more likely it will be that such cooperation will increase.

APPENDIX A

MEMORANDUM ON MBTA SUBURBAN TRANSPORTATION PROGRAM

CTPS

State Transportation Building
Ten Park Plaza, Sute 2150
Boston, MA 02116-3968
(617) 973-7100
Fax: (617) 973-8855
TDD: (617) 973-7089

Central Transportation Planning Staff

MEMORANDUM

TO: PMT Files March 11, 1993

FROM: Thomas J. Humphrey

RE: Background of MBTA Suburban Transportation Program

I. Introduction

The MBTA Suburban Transportation Program was launched over 17 years ago. In this time, funds have been provided for fixed-route or demand-responsive services in 14 cities and towns in the MBTA District. Ten systems (in Boston, Bedford, Beverly, Burlington, Dedham, Framingham, Lexington, Lynn, Natick, and Norwood) are still in operation. The other four have shut down, mainly for lack of local-share funding. Information on performance of the present and past suburban systems would be useful in predicting success of proposed future systems. Unfortunately, there is no single document to which one can turn to learn what routes these systems served, how much service was provided, how much ridership there was, and what the financial results were. This memorandum is the start of an attempt to create such a document. Because of time limitations, and the scattered locations of the desired information, much work remains to be done.

II. First MBTA Suburban Transportation Program - 1975 to 1981

The MBTA Suburban Transportation Program was initiated by EOTC in 1975, in response to complaints that the established MBTA bus system did not serve local travel needs in many outlying areas. When first announced, the program was to provide $200,000 for a one-year demonstration of up to five new community-based transportation systems. Each town was required to fund 50 percent of the cost of its system. Cities and towns that already had extensive MBTA bus service were to be ineligible for funding. These included Boston, 12 of the 13 other communities in the MBTA "inner 14," and Quincy, Beverly, Salem, Lynn, Swampscott and Nahant.

Proposals from Bedford, Needham, and Natick were accepted for the initial demonstration, with all three systems starting during 1976. The Bedford system originally included one fixed route from Bedford Center to the Burlington Mall, with two additional vehicles providing demand-responsive service. The Needham system consisted of four loop routes converging at Needham Center, and designed to provide service within convenient walking distance of 70 percent of the town's population. The primary focus was on shopping trips to

the town's main business district, but some peak-period trips were scheduled as feeders to commuter rail service at Needham Center and Bird's Hill (Hersey). The Natick system was similar to the Bedford system. It had one fixed route from Natick Common to Natick Mall. Two additional vehicles provided demand-responsive service between Natick Common and 25 specified locations in the town.

Ridership on these three systems during the original demonstration year was sufficiently good that MBTA funding was continued for a second year. In 1978, the MBTA Board of Directors voted to make the Suburban Transportation Program permanent. New systems were to be given two-year trials. If certain performance standards were met by the end of that time, the systems were to be eligible for renewed funding on a year-to-year basis.

Along with the original three suburban systems, the program began funding systems in Lexington and Winchester in 1980. The Lexington system (Lexpress) was similar to the Needham system. Eight loop routes converged on the downtown area, and offered service within walking distance of the majority of town population. Like the Bedford system, the Lexington system included an inter-town route to the Burlington Mall. Information on the Winchester system is not readily available, but it probably included feeder service to commuter rail.

MBTA funding of the Suburban Transportation Program was eliminated entirely in January 1981, because of budget problems that led to massive cutbacks in all MBTA services. Nevertheless, all the suburban systems except the one in Winchester continued operating with town funding only.

Second Suburban Transportation Program - 1984 To Present

The MBTA Suburban Transportation Program was revived in 1984, under a new administration. The systems in Natick, Needham, Bedford and Lexington started under the first program had been maintained with local funding since 1981, and all again received MBTA assistance. The Winchester system was not revived. The Needham system ran until June 1990, when it was suspended for lack of local funding, The others are still operating.

Along with the four older systems, funding in 1984 was extended to systems in Dedham, Framingham, and Norwood. The Dedham system consisted of routes already operated by Hudson Bus Lines. These had been operated previously by a series of other carriers including the MBTA itself, and most segments dated from the 1920s and 1930s. This service is still operating

The Framingham system (LIFT) restored routes from downtown Framingham to Framingham Center, Nobscot, Saxonville, and Natick Mall. A private carrier had discontinued these a few years earlier. The portions of these routes furthest from downtown Framingham had been started in the late 1940s

and early 1950s to serve post-war housing tracts. Some segments closer to downtown can be traced back to replacement service for turn-of-the-century streetcar routes. About 1987, a discontinued private-carrier route from Hopkinton and Ashland to Framingham was also restored as part of the LIFT system. The LIFT system is still operating.

The Norwood system differs from others in the Suburban Transportation Program in that it involves no fixed-route service. Instead, it provides taxi fare subsidies for elderly and special needs passsengers.

MBTA funding of the first seven systems in the revived Suburban Transportation Program began in Fiscal 1985. The same seven were funded the next year. In Fiscal 1987, MBTA funding was approved for systems in Hamilton, Braintree, and Weymouth. The Hamilton system was to have provided a limited demand-responsive service for special needs passengers, but was never implemented. The Weymouth and Braintree services were all part of one system, (Weybus) sponsored by the town of Weymouth. Five routes radiated from a shopping plaza at Middle and Washington Streets, near the geographic center of Weymouth. They coveredmost sections of that town. The Braintree service consisted of extensions of two of these routes to the South Shore Plaza via the Braintree Red Line Station. Much of the street coverage of Weybus reinstated previously abandoned private-carrier routes.

In 1989, Weybus took over operation of MBTA express bus Route 252, from South Weymouth to Braintree Station via state Route 3. This was a relatively new service, started by the MBTA in 1982. It also had the lowest ridership in the MBTA system, at 87 passengers a day. The entire Weybus system ceased operating in 1990, when voters at the town meeting rejected further funding. The former Weybus contractor continued operating Route 252 without subsidy for about one year. Since then it has been operated by private carriers without subsidies, although ridership has remained low.

Three more systems were added to the program in Fiscal 1988. All of these were in communities specifically excluded from eligibility when the program began in 1975. The Mission Hill Link system had been running for a few years before it received MBTA funding. This system consists of three route variations serving the Mission Hill area of Boston. The routes are relatively short, but serve a hilltop area with unusual access problems.

The second new system added in FY 1988 was in Lynn. It consists of two loop lines, one serving points east of Central Square and one serving points west. These routes had originated about 1973 as MBTA minibus routes 466 and 467. Some portions of the routes overlapped or closely paralleled other MBTA services and some were new. After being discontinued by the MBTA in 1977, they had been taken over by a private carrier with funding from the City of Lynn.

The third new system added in FY 88 was in Beverly. It consists of one route, the Beverly Shopper's Shuttle. This is a "figure 8," centered at the Beverly commuter rail station and running northeast to the Beverly Hospital and west to the Danvers town line. Operation began in December 1987. Much of the route was a restoration of old MBTA bus routes discontinued in the early 1970s.

The most recent addition to the program is a system in Burlington, which began operating on November 7, 1988. It consists of six loop routes centered on the town common. Previously, Burlington had been served by MBTA routes to Boston and to Alewife Station, but had no routes designed for intra-town travel. A private carrier had started local service in 1968, but it operated only briefly.

Table 1 shows average daily ridership on each Suburban Transportation Program system for fiscal years 1988 to 1992. All figures are based on information in MBTA "blue book" Ridership and Service Statistics reports. The wide range in ridership among systems is partly a result of differences in the number of routes and trips operated. Bedford, which had the lowest daily ridership in each year shown, had only one fixed route, operating two round trips per day, but also had demand-responsive van service.

Lexington, which always had the highest ridership, also had the most service. Before 1990, there were eight routes, with 92 weekday and 64 Saturday departures. (Most of the routes are loops, making each departure a round trip.) In 1990, service was reduced to six routes, with 69 weekday and 48 Saturday departures. This change, and a fare increase from 50 to 75 cents, may explain this system's substantial ridership drop. On a per-trip basis, Lexpress averaged 7.0 riders in FY 92 versus 8.7 in FY 88.

Table 1
MBTA Suburban Transportation Program Ave. Riders Per Day FY 88 - FY 92

System	Fy 88	Fy 89	Fy 90	Fy 91	Fy 92
Bedford	25.3	24.4	26.6	28.6	30.1
Beverly	62.4	78.1	80.9	164.2	132.5
Dedham	173.5	153.9	132.5	125.9	128.5
Framingham	668.7	446.2	393.3	331.6	332.2
Lexington	762.2	513.6	393.9	379.7	452.6
Lynn	120.1	96.6	79.2	68.3	86.2
Mission Hill	285.6	269.4	168.8	242.0	192.9
Natick	129.2	126.1	125.3	138.0	141.6
Needham	130.3	113.3	119.4	discontinued	discontinued
Norwood	43.1	46.5	42.5	43.3	37.0
Weymouth	164.7	214.2	296.3	discontinued	discontinued
Braintree	59.0	105	136.6	discontinued	discontinued
Burlington	not started	153.3	175.6	176.1	177.6

Other Suburban Bus Systems in the MBTA District

Since 1975, several cities and towns within the MBTA District have set up community-based bus services similar to those included in the Suburban Transportation Program, but without MBTA funding. Some of these were in locations ineligible under the original guidelines. Others applied for, but did not receive, MBTA funds. Because of similarities between these systems and those in the Program, all on which information has been found are described below.

Sudbury

In February 1975, a few months before the establishment of the Suburban Transportation Program, the Town of Sudbury inaugurated a local bus system called Sudbus. Two 20-passenger buses provided service eight hours a day, six days a week. Seven routes, all starting at the Sudbury Plaza on the Boston Post Road in South Sudbury radiated out to provide service to within walking distance of most populated sections of the town. Most of the routes had two-direction operation except for short one-way loops at the outer ends. The service was operated by Big W Trans., which contracted with the town to provide buses at fixed hourly rates

The town initially appropriated $25,000 to subsidize the service, which had been proposed and designed by a citizens' committee. After six weeks of operation, ridership stabilized at around 1,100 passengers per week, or 180 per day. This was an average of 26 rides per route per day. Proponents of the system had predicted that there would be 10,000 riders per week. After a few months, further funding of the Sudbus was voted down in the town meeting, and the system shut down permanently.

Newton

In the fall of 1980, the City of Newton inaugurated a local bus system called The Newton Rider. It was funded by a combination of City money and contributions from city merchants. Four routes intersected at Newton Centre Square. They were operated in two interlined pairs, each with a single route designation number, but with separate fares for each half. A more elaborate system was planned, but was not implemented because of limited funds. Standard school buses were used on both routes.

Route 1 ran from the Chestnut Hill Green Line Station via State Route 9 and Langley Road to Newton Centre. From there, it ran via Centre and Needham Streets to the Needham Industrial Park, where it made a long one-way loop. Route 2 originally ran from the Lake Street Green Line terminal to Riverside Station via Commonwealth Avenue and Centre Streets, Newton Centre Square, Beacon Street, through Waban to Washington Street, and Route 128 to Grove Street to Riverside. A side diversion served the Newton-Wellesley Medical

Building. Within a few weeks, the outer terminal was changed from Riverside to the Newton Marriot Hotel.

Most segments of both routes either overlapped then-existing MBTA bus routes, or restored service of previously discontinued MBTA or private-carrier routes. Route 1 was operated by Commonwealth Coach, on 30-minute headways Monday through Saturday. Route 2 was operated by Andre Coach Lines on hourly headways Monday through Friday.

Two months after it started, the service was reported to be in serious trouble. Ridership was under 600 per week, or about 55 passengers per route-pair per day. A minimum goal of 300 total riders per day had been set by the City. Service almost ended in December 1980, but was continued because of an influx of student riders resulting from cutbacks in school bus service. Even with this gain, total ridership remained below 150 per day. The Newton Rider finally shut down at the end of June 1982. (In December 1984, a new variation of MBTA Route 59 restored service to Needham Street, but it has never been well patronized.)

Concord

About 1974, the town of Concord established a network of free shuttle buses serving Concord Center. This service was funded by the town. Details on the original configuration of this service have not yet been obtained. Originally called Concord Community Bus, the service was re-named Contran about 1990. According to Car-Free in Boston, Contran was still operating in the summer of 1992, but on a very limited basis. Buses were then operating only on Monday, Wednesday, and Friday mornings, on routes connecting Concord Center with shopping areas in adjoining towns.

Marblehead

In July 1975, the town of Marblehead approved funds for a free bus route to provide downtown circulation. Later that year, the town applied unsuccessfully for funding for this service under the original MBTA Suburban Transportation Program. It is unclear if this service was ever operated.

Manchester

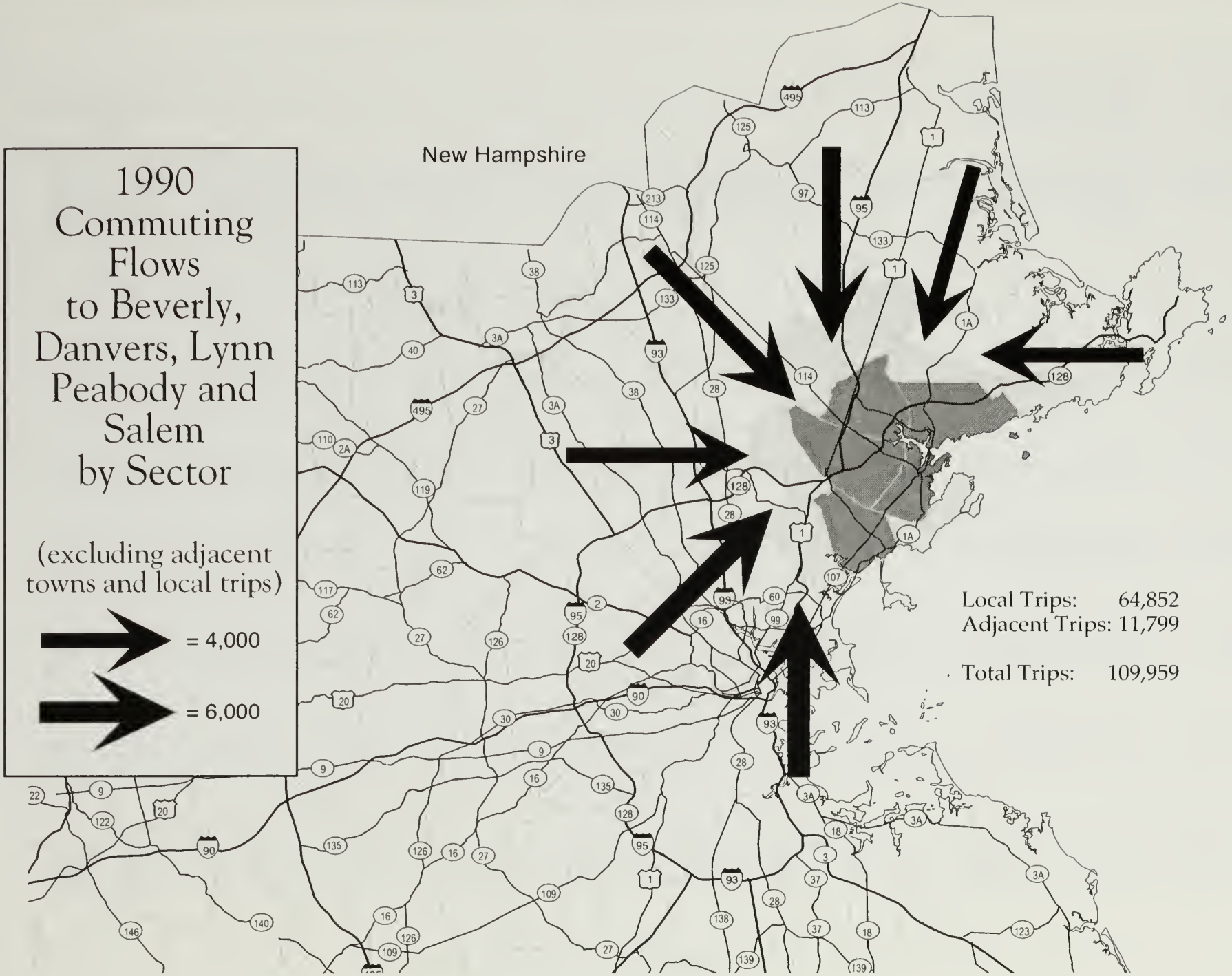
In October 1979, the MBTA granted operating rights to Manchester Transportation Services, Inc. for three routes radiating west, north and east from the Manchester commuter rail station and south to Singing Beach. No other information about this service has been found.

TJH/tjh

APPENDIX B

1990 JOURNEY-TO-WORK MAPS AND DATA FOR SUBURBAN CLUSTERS

Data Source: U.S. Census Bureau

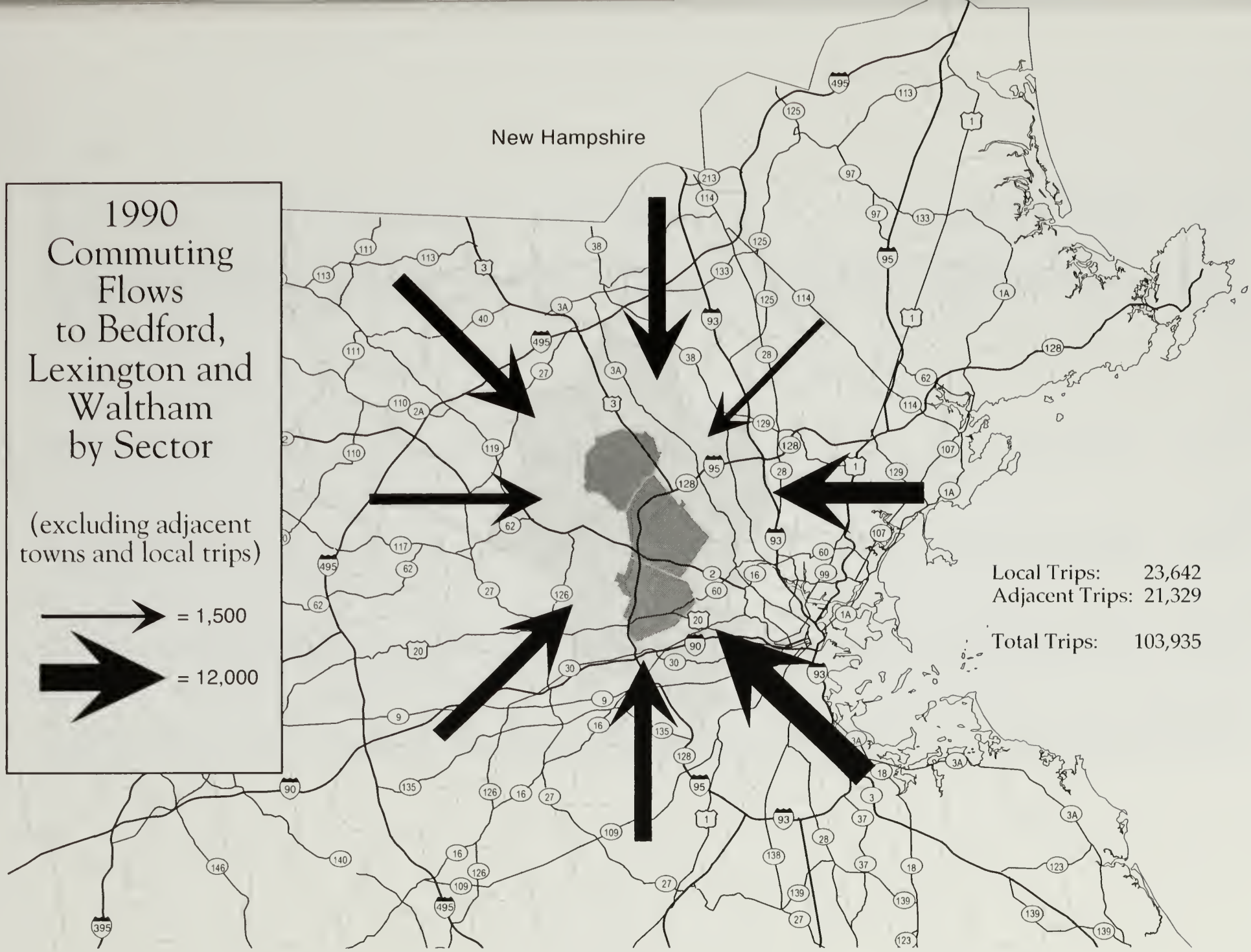

1990
Commuting
Flows
to Beverly,
Danvers, Lynn
Peabody and
Salem
by Sector
(excluding adjacent
towns and local trips)
= 4,000
= 6,000
New Hampshire
Local Trips: 64,852
Adjacent Trips: 11,799
Total Trips: 109,959

Sector	Residence	Work in Beverly	Work in Danvers	Work in Lynn	Work in Peabody	Work in Salem	Combined
Local	Beverly	6,531	1,975	701	1,068	1,782	12,057
Local	Danvers	954	4,145	659	1,169	721	7,648
Local	Lynn	471	831	14,545	1,809	2,118	19,774
Local	Peabody	890	2,452	2,058	6,326	1,910	13,636
Local	Salem	1,067	1,501	1,318	1,677	6,174	11,737
	Total						64,852
Adjacent	Lynnfield	77	197	382	320	51	1,027
Adjacent	Manchester	235	138	65	105	161	704
Adjacent	Marblehead	280	203	769	373	948	2,573
Adjacent	Middleton	104	367	122	164	115	872
Adjacent	Nahant	26	14	532	42	56	670
Adjacent	Saugus	72	233	1,256	418	168	2,147
Adjacent	Swampscott	144	92	1,103	213	695	2,247
Adjacent	Topsfield	175	348	196	122	68	909
Adjacent	Wenham	209	218	72	74	77	650
	Total						11,799
W	Acton	-	7	2	-	-	9
W	Ayer	-	9	-	8	-	17
W	Bedford	7	12	10	14	27	70
W	Billerica	31	63	46	105	-	245
W	Bolton	-	-	-	7	-	7
W	Burlington	24	35	92	96	56	303
W	Carlisle	6	4	-	-	-	10
W	Chelmsford	26	32	27	50	20	155
W	Clinton	-	-	-	8	4	12
W	Concord	7	6	7	16	-	36
W	Dunstable	-	-	3	3	-	6
W	Fitchburg	-	12	6	-	10	28
W	Gardner	11	-	-	-	-	11
W	Groton	-	26	-	6	-	32
W	Hudson	6	18	-	25	35	84
W	Lancaster	-	12	-	-	-	12
W	Leominster	-	-	9	-	11	20
W	Lexington	-	57	77	42	48	224
W	Lincoln	-	7	-	-	13	20
W	Littleton	-	9	-	-	8	17
W	Marlborough	-	9	17	52	-	78
W	Maynard	14	-	-	-	-	14
W	Northborough	-	17	-	-	-	17
W	Pepperell	12	-	-	-	-	12
W	Reading	42	119	158	153	30	502
W	Shirley	-	-	-	25	-	25
W	Shrewsbury	-	6	-	-	6	12
W	Stoneham	29	71	108	112	45	365
W	Sudbury	13	-	15	7	-	35
W	Wakefield	106	132	204	168	15	625
W	Westford	-	13	12	17	5	47
W	Wilmington	14	47	103	97	28	289
W	Woburn	108	109	90	123	33	463
W	Worcester	-	6	5	9	-	20
	Total						3,822
SW	Arlington	-	45	81	70	59	255
SW	Ashland	-	7	-	10	6	23
SW	Belmont	8	18	22	17	22	87
SW	Blackstone	-	-	-	-	9	9
SW	Brookline	20	9	59	76	20	184
SW	Cambridge	20	31	155	44	30	280

Sector	Residence	Work in Beverly	Work in Danvers	Work in Lynn	Work in Peabody	Work in Salem	Combined
SW	Charlton	-	-	-	8	-	8
SW	Dedham	11	20	-	7	14	52
SW	Douglas	-	-	8	-	-	8
SW	Everett	24	28	199	97	61	409
SW	Framingham	-	51	18	70	9	148
SW	Franklin	-	9	-	14	15	38
SW	Grafton	-	-	-	8	-	8
SW	Holliston	-	-	-	17	-	17
SW	Hopedale	-	6	-	-	-	6
SW	Hopkinton	17	9	7	-	-	33
SW	Malden	53	135	351	194	29	762
SW	Medfield	28	8	-	-	-	36
SW	Medford	79	123	282	110	38	632
SW	Medway	-	11	-	8	-	19
SW	Melrose	31	72	316	136	69	624
SW	Mendon	-	15	-	14	-	29
SW	Milford	-	12	-	17	6	35
SW	Natick	5	8	24	31	-	68
SW	Needham	6	30	32	31	22	121
SW	Newton	28	68	146	136	51	429
SW	Norfolk	-	-	7	-	-	7
SW	North Attleborough	8	-	13	-	-	21
SW	Northbridge	7	-	8	-	-	15
SW	Norwood	-	28	14	-	-	42
SW	Oxford	-	-	-	-	20	20
SW	Plainville	-	-	-	7	-	7
SW	Rhode Island	7	26	33	25	68	159
SW	Sherborn	-	-	-	11	6	17
SW	Somerville	45	41	273	94	27	480
SW	Southborough	-	6	-	7	-	13
SW	Upton	-	15	-	-	-	15
SW	Uxbridge	7	-	-	-	-	7
SW	Waltham	27	22	69	91	22	231
SW	Watertown	24	25	48	28	13	138
SW	Wayland	6	7	7	-	24	44
SW	Webster	-	-	6	-	-	6
SW	Wellesley	12	6	36	11	-	65
SW	Westborough	-	-	-	10	5	15
SW	Weston	-	-	7	12	-	19
SW	Westwood	-	9	14	-	11	34
SW	Winchester	18	36	38	46	22	160
SW	Wrentham	-	-	8	18	-	26
	Total						5,861
S	Abington	-	11	19	-	-	30
S	Acushnet	-	6	-	-	-	6
S	Attleboro	-	-	11	-	-	11
S	Barnstable	10	-	-	-	-	10
S	Boston	166	311	1,205	367	302	2,351
S	Braintree	13	9	34	7	-	63
S	Bridgewater	-	7	10	9	-	26
S	Brockton	16	16	45	76	-	153
S	Canton	10	-	29	24	6	69
S	Carver	-	-	7	-	-	7
S	Chelsea	26	18	138	48	75	305
S	Dartmouth	-	5	-	-	9	14
S	Dighton	6	5	-	-	-	11
S	Duxbury	6	8	-	-	-	14
S	East Bridgewater	-	-	6	-	-	6
S	Easton	11	-	7	-	-	18

Sector	Residence	Work in Beverly	Work in Danvers	Work in Lynn	Work in Peabody	Work in Salem	Combined
S	Fairhaven	-	3	-	-	-	3
S	Fall River	-	-	8	-	3	11
S	Falmouth	-	-	6	-	-	6
S	Foxborough	-	-	17	17	-	34
S	Halifax	-	8	-	-	9	17
S	Hanover	7	7	6	-	6	26
S	Hanson	-	-	7	7	-	14
S	Hingham	-	-	17	-	6	23
S	Hull	-	-	-	-	17	17
S	Kingston	-	17	-	-	-	17
S	Lakeville	-	-	-	-	11	11
S	Mansfield	-	7	20	7	-	34
S	Marshfield	10	-	20	24	16	70
S	Middleborough	-	-	13	11	-	24
S	Milton	15	5	42	-	19	81
S	New Bedford	-	17	8	-	18	43
S	Norton	-	-	10	-	7	17
S	Norwell	13	-	12	-	-	25
S	Pembroke	-	7	6	-	5	18
S	Plymouth	13	-	16	29	-	58
S	Quincy	9	19	52	90	60	230
S	Randolph	27	18	12	23	-	80
S	Rehoboth	-	5	8	-	-	13
S	Revere	57	181	598	213	130	1,179
S	Rockland	-	-	-	8	7	15
S	Sandwich	-	-	7	-	-	7
S	Scituate	-	-	8	5	8	21
S	Sharon	14	-	22	6	-	42
S	Somerset	-	-	8	-	-	8
S	Stoughton	-	11	16	13	19	59
S	Taunton	-	11	11	18	-	40
S	Wareham	-	13	-	-	-	13
S	Weymouth	11	29	56	6	15	117
S	Whitman	-	-	14	6	4	24
S	Winthrop	24	21	221	34	32	332
	Total						5,823
E	Essex	125	134	11	47	52	369
E	Gloucester	596	441	169	417	259	1,882
E	Hamilton	560	272	114	166	187	1,299
E	Rockport	245	119	63	34	69	530
	Total						4,080
NE	Hampton	8	69	12	24	31	144
NE	Hampton Falls	-	6	4	6	11	27
NE	Ipswich	336	265	163	290	259	1,313
NE	Maine	33	33	17	36	44	163
NE	Newbury	82	73	83	89	83	410
NE	Newburyport	179	228	109	157	140	813
NE	North Hampton	19	19	6	12	-	56
NE	Portsmouth	9	6	-	5	-	20
NE	Rowley	161	223	98	80	102	664
NE	Rye	-	17	10	15	-	42
NE	Salisbury	37	97	44	78	18	274
NE	Seabrook	51	49	22	42	-	164
	Total						4,090
N	Amesbury	93	282	116	165	83	739
N	Boxford	70	210	192	142	99	713
N	Brentwood	-	-	10	2	5	17

Sector	Residence	Work in Beverly	Work in Danvers	Work in Lynn	Work in Peabody	Work in Salem	Combined
N	Danville	12	10	6	7	6	41
N	Dover NH	15	20	-	10	-	45
N	Durham	-	12	-	7	7	26
N	E Kingston	7	6	2	-	-	15
N	Epping	14	14	13	21	7	69
N	Exeter	16	67	26	39	-	148
N	Fremont	6	15	15	5	2	43
N	Georgetown	135	245	203	112	46	741
N	Greenland	5	5	-	13	-	23
N	Groveland	51	147	127	73	56	454
N	Haverhill	144	345	150	167	154	960
N	Kensington	2	5	2	7	-	16
N	Kingston NH	24	32	26	27	12	121
N	Lee	8	-	13	-	-	21
N	Merrimac	12	18	33	-	32	95
N	Newmarket	-	42	29	-	8	79
N	Newton NH	7	21	27	15	8	78
N	Plaistow	15	28	49	-	-	92
N	S Hampton	2	4	5	-	-	11
N	Somersworth	6	16	-	11	-	33
N	Stratham	14	33	16	17	-	80
N	West Newbury	42	62	33	37	38	212
	Total						4,872
NW	Amherst NH	-	7	-	-	-	7
NW	Andover	77	172	120	107	106	582
NW	Atkinson	10	22	-	22	-	54
NW	Bedford NH	-	9	-	11	-	20
NW	Candia	-	-	17	-	-	17
NW	Chester	10	-	-	4	-	14
NW	Concord NH	-	5	-	9	4	18
NW	Derry	25	49	39	57	28	198
NW	Dracut	16	27	32	25	8	108
NW	Goffstown	-	-	-	13	-	13
NW	Hampstead	36	18	-	9	-	63
NW	Hooksett	-	7	28	-	-	35
NW	Hudson NH	21	-	9	6	13	49
NW	Lawrence	104	160	125	67	98	554
NW	Londonderry	6	32	15	6	9	68
NW	Lowell	7	63	86	74	61	291
NW	Manchester NH	-	47	-	13	20	80
NW	Merrimack	-	-	13	8	-	21
NW	Methuen	116	156	100	58	42	472
NW	Milford NH	-	-	-	-	6	6
NW	Nashua	5	70	39	41	5	160
NW	North Andover	53	188	75	224	109	649
NW	North Reading	32	114	139	96	54	435
NW	Pelham	14	8	37	-	-	59
NW	Raymond	-	32	12	23	15	82
NW	Salem NH	43	60	72	49	62	286
NW	Sandown	13	6	13	12	12	56
NW	Tewksbury	16	91	102	48	35	292
NW	Tyngsborough	10	-	-	-	-	10
NW	Windham	8	7	37	9	-	61
	Total						4,760
	Grand Total	16,409	20,303	32,930	20,912	19,405	109,959

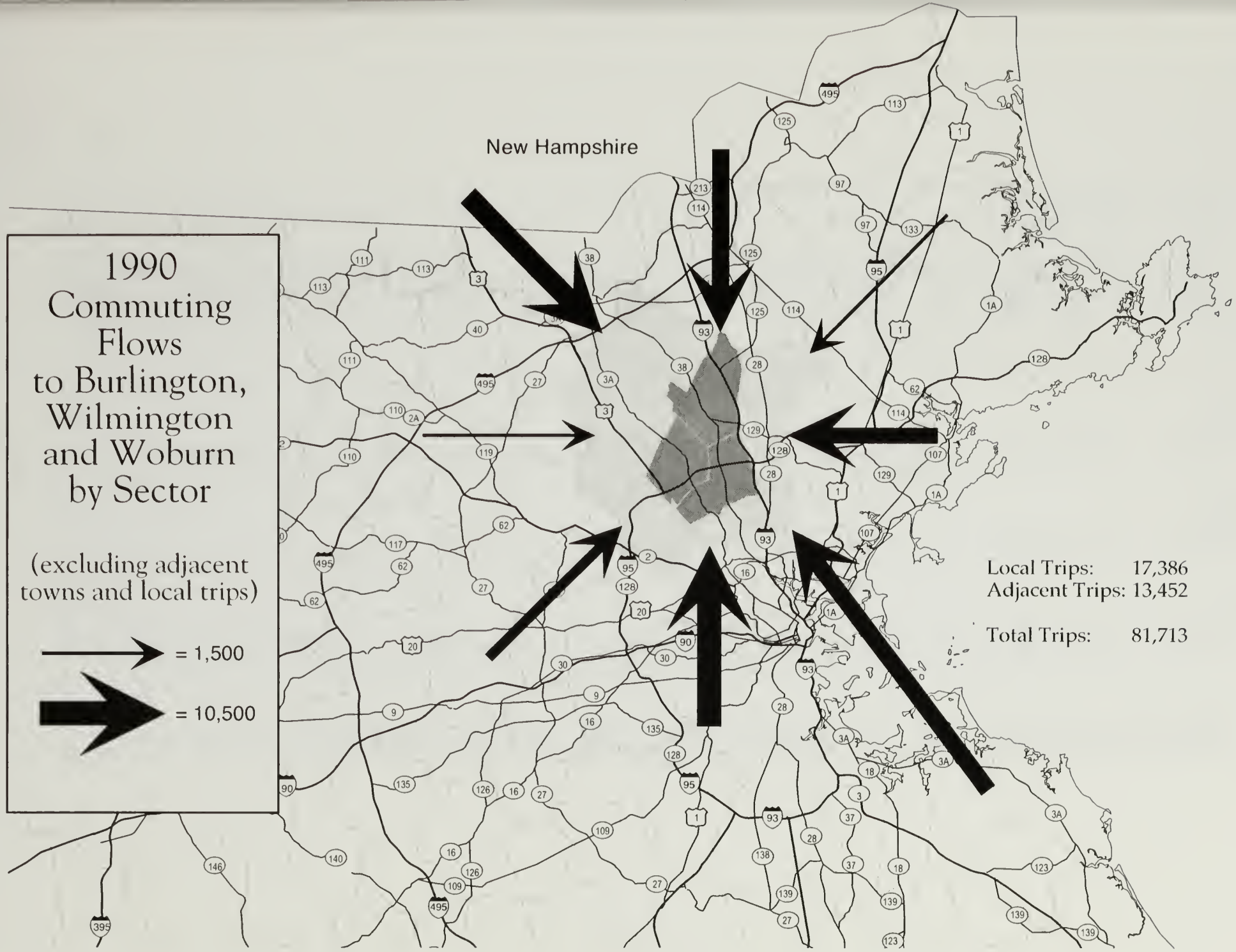

1990
Commuting
Flows
to Bedford,
Lexington and
Waltham
by Sector
(excluding adjacent
towns and local trips)
= 1,500
= 12,000
New Hampshire
Local Trips: 23,642
Adjacent Trips: 21,329
Total Trips: 103,935

Sector	Residence	Work in Bedford	Work in Lexington	Work in Waltham	Combined
Local	Bedford	2,436	873	345	3,654
Local	Lexington	663	3,004	1,087	4,754
Local	Waltham	407	955	13,872	15,234
	Total				23,642
Adjacent	Arlington	517	1,107	1,191	2,815
Adjacent	Belmont	109	296	795	1,200
Adjacent	Billerica	1,691	666	827	3,184
Adjacent	Burlington	808	551	690	2,049
Adjacent	Carlisle	205	162	83	450
Adjacent	Concord	294	421	449	1,164
Adjacent	Lincoln	1,237	155	246	1,638
Adjacent	Newton	327	383	2,497	3,207
Adjacent	Watertown	175	182	2,094	2,451
Adjacent	Weston	43	118	331	492
Adjacent	Winchester	160	319	336	815
Adjacent	Woburn	522	624	718	1,864
	Total				21,329
W	Acton	401	427	378	1,206
W	Berlin	7	6	23	36
W	Bolton	7	18	29	54
W	Boxborough	67	81	46	194
W	Boylston	-	-	10	10
W	Clinton	55	58	59	172
W	Fitchburg	74	90	147	311
W	Gardner	29	21	13	63
W	Harvard	65	51	80	196
W	Holden	-	11	7	18
W	Hudson	165	97	293	555
W	Lancaster	24	24	29	77
W	Leominster	145	74	108	327
W	Lunenburg	60	-	38	98
W	Maynard	104	176	235	515
W	Shirley	21	32	61	114
W	Sterling	9	17	8	34
W	Stow	107	48	118	273
W	Templeton	-	13	6	19
W	Westminster	10	17	-	27
	Total				4,299
SW	Ashland	24	41	215	280
SW	Bellingham	-	-	46	46
SW	Blackstone	8	-	30	38
SW	Charlton	-	26	28	54
SW	Douglas	5	-	8	13
SW	Dudley	-	-	4	4
SW	Framingham	201	276	1,151	1,628
SW	Grafton	5	33	74	112
SW	Holliston	38	72	172	282
SW	Hopedale	18	5	36	59
SW	Hopkinton	-	18	96	114
SW	Marlborough	125	155	720	1,000
SW	Medway	16	4	129	149
SW	Mendon	-	-	23	23
SW	Milford	24	75	143	242
SW	Millbury	-	7	40	47
SW	Natick	124	122	674	920
SW	Northborough	18	51	78	147
SW	Northbridge	7	-	32	39
SW	Oxford	-	-	17	17
SW	Sherborn	-	20	58	78
SW	Shrewsbury	39	-	109	148
SW	Southborough	9	26	100	135
SW	Southbridge	-	-	15	15
SW	Sudbury	216	217	375	808

Sector	Residence	Work in Bedford	Work in Lexington	Work in Waltham	Combined
SW	Sutton	-	-	8	8
SW	Upton	22	6	50	78
SW	Uxbridge	-	-	30	30
SW	Wayland	146	127	562	835
SW	Webster	6	-	11	17
SW	Westborough	37	14	151	202
SW	Worcester	78	13	267	358
	Total				7,926
S	Attleboro	6	34	123	163
S	Berkley	14	-	22	36
S	Canton	28	70	192	290
S	Dartmouth	-	8	8	16
S	Dedham	41	69	282	392
S	Dighton	-	-	29	29
S	Dover	17	46	66	129
S	Easton	18	44	179	241
S	Fairhaven	-	-	7	7
S	Fall River	18	5	66	89
S	Foxborough	28	53	97	178
S	Franklin	47	26	148	221
S	Freetown	22	-	10	32
S	Lakeville	-	-	19	19
S	Mansfield	27	-	115	142
S	Medfield	40	19	133	192
S	Millis	-	31	77	108
S	Needham	57	97	466	620
S	New Bedford	11	5	143	159
S	Norfolk	18	-	81	99
S	North Attleborough	37	-	94	131
S	Norton	-	39	64	103
S	Norwood	60	70	436	566
S	Plainville	-	8	38	46
S	Raynham	-	31	38	69
S	Rhode Island	127	117	452	696
S	Seekonk	-	37	-	37
S	Sharon	-	41	90	131
S	Somerset	-	-	25	25
S	Stoughton	26	53	291	370
S	Swansea	-	-	31	31
S	Taunton	8	19	155	182
S	Walpole	58	79	215	352
S	Wellesley	61	89	556	706
S	Westwood	55	50	143	248
S	Wrentham	7	13	47	67
	Total				6,922
SE	Abington	12	5	43	60
SE	Avon	-	5	42	47
SE	Barnstable	6	-	15	21
SE	Boston	561	809	4,477	5,847
SE	Bourne	-	-	13	13
SE	Braintree	28	29	161	218
SE	Bridgewater	-	36	73	109
SE	Brockton	7	102	306	415
SE	Brookline	71	109	521	701
SE	Cambridge	202	525	1,342	2,069
SE	Carver	9	-	33	42
SE	Cohasset	-	30	39	69
SE	Duxbury	-	8	59	67
SE	East Bridgewater	-	15	20	35
SE	Falmouth	10	7	18	35
SE	Halifax	-	-	23	23
SE	Hanover	-	7	41	48
SE	Hanson	-	7	7	14
SE	Hingham	27	34	85	146

Sector	Residence	Work in Bedford	Work in Lexington	Work in Waltham	Combined
SE	Holbrook	-	34	52	86
SE	Hull	-	-	26	26
SE	Marshfield	6	7	58	71
SE	Mashpee	10	6	-	16
SE	Middleborough	-	-	21	21
SE	Milton	16	20	170	206
SE	Norwell	-	22	70	92
SE	Pembroke	-	7	53	60
SE	Plymouth	21	27	90	138
SE	Plympton	2	4	4	10
SE	Quincy	82	51	355	488
SE	Randolph	71	53	141	265
SE	Rochester	-	-	15	15
SE	Rockland	-	-	60	60
SE	Sandwich	6	-	22	28
SE	Scituate	16	37	49	102
SE	Wareham	-	-	9	9
SE	West Bridgewater	-	-	46	46
SE	Weymouth	18	86	191	295
SE	Whitman	-	7	63	70
SE	Yarmouth	13	-	14	27
	Total				12,110
E	Beverly	145	95	80	320
E	Chelsea	3	25	168	196
E	Danvers	49	73	35	157
E	Essex	-	4	-	4
E	Everett	58	77	199	334
E	Gloucester	45	67	75	187
E	Lynn	119	184	194	497
E	Lynnfield	102	18	94	214
E	Malden	102	195	482	779
E	Manchester	32	22	37	91
E	Marblehead	64	34	76	174
E	Medford	162	411	659	1,232
E	Melrose	146	175	142	463
E	Nahant	8	6	14	28
E	Peabody	133	159	283	575
E	Revere	73	102	285	460
E	Rockport	15	-	-	15
E	Salem	74	110	154	338
E	Saugus	48	69	122	239
E	Somerville	209	399	1,295	1,903
E	Stoneham	108	131	269	508
E	Swampscott	42	11	23	76
E	Wakefield	152	106	262	520
E	Winthrop	36	15	54	105
	Total				9,415
NE	Amesbury	46	30	14	90
NE	Boxford	14	-	68	82
NE	Durham	15	-	21	36
NE	E Kingston	-	2	1	3
NE	Exeter	19	-	42	61
NE	Georgetown	-	8	45	53
NE	Greenland	-	-	7	7
NE	Groveland	13	40	15	68
NE	Hamilton	24	16	40	80
NE	Hampton	10	8	23	41
NE	Haverhill	94	127	116	337
NE	Ipswich	4	20	32	56
NE	Kingston NH	-	20	8	28
NE	Lawrence	177	136	102	415
NE	Merrimac	34	-	22	56
NE	Middleton	34	16	63	113
NE	Newbury	26	-	31	57

Sector	Residence	Work in Bedford	Work in Lexington	Work in Waltham	Combined
NE	Newburyport	26	53	67	146
NE	Newmarket	-	-	6	6
NE	North Andover	83	130	97	310
NE	North Reading	57	57	106	220
NE	Plaistow	-	10	30	40
NE	Portsmouth	-	7	17	24
NE	Reading	186	228	312	726
NE	Rowley	9	7	12	28
NE	Rye	8	-	-	8
NE	Salisbury	10	7	-	17
NE	Seabrook	8	7	15	30
NE	Somersworth	16	-	-	16
NE	Stratham	12	-	-	12
NE	Topsfield	16	19	19	54
NE	Wenham	9	8	13	30
NE	West Newbury	5	-	6	11
NE	Wilmington	197	223	189	609
	Total				3,870
N	Andover	152	177	252	581
N	Atkinson	15	18	42	75
N	Auburn	-	14	36	50
N	Concord NH	17	-	11	28
N	Danville	2	2	-	4
N	Derry	144	47	56	247
N	Dracut	605	249	146	1,000
N	Hampstead	-	8	-	8
N	Londonderry	90	23	71	184
N	Lowell	1,787	363	407	2,557
N	Manchester NH	112	60	66	238
N	Methuen	86	90	135	311
N	Pelham	71	18	54	143
N	Salem NH	105	102	97	304
N	Sandown	14	7	-	21
N	Tewksbury	510	234	290	1,034
N	Windham	37	33	23	93
	Total				6,878
NW	Amherst	19	13	42	74
NW	Ayer	81	40	21	142
NW	Bedford NH	26	16	11	53
NW	Brookline NH	15	4	6	25
NW	Chelmsford	1,023	617	397	2,037
NW	Dunstable	48	19	15	82
NW	Goffstown	7	10	9	26
NW	Groton	97	30	55	182
NW	Hollis	20	25	24	69
NW	Hudson NH	145	52	90	287
NW	Litchfield	8	34	6	48
NW	Littleton	113	128	67	308
NW	Mason	3	4	17	24
NW	Merrimack	205	127	92	424
NW	Milford NH	49	57	-	106
NW	Nashua	1,033	413	356	1,802
NW	Pepperell	116	63	9	188
NW	Townsend	105	59	89	253
NW	Tyngsborough	195	101	48	344
NW	Westford	409	374	287	1,070
	Total				7,544
	Grand Total	24,676	22,925	56,334	103,935

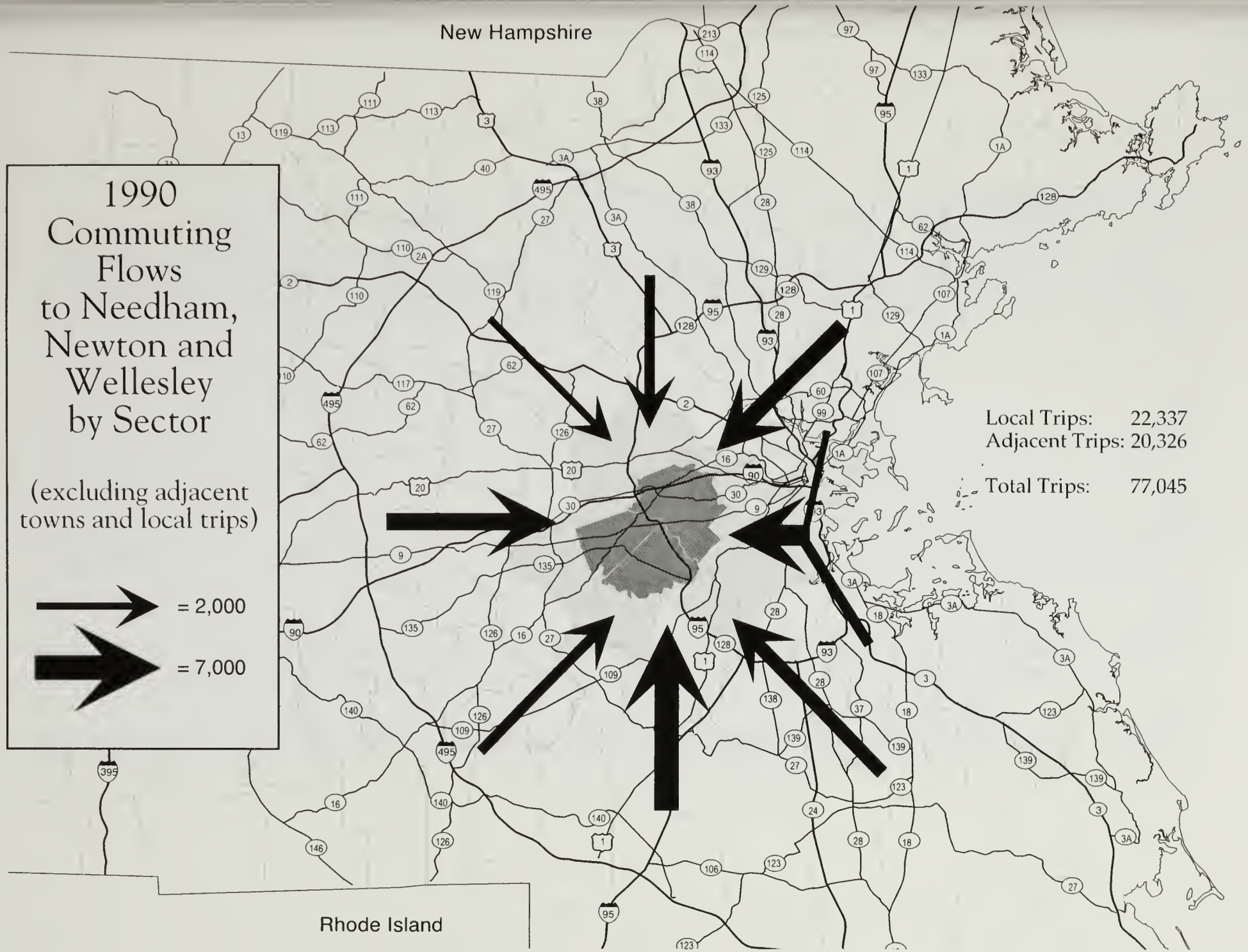

1990
Commuting
Flows
to Burlington,
Wilmington
and Woburn
by Sector
(excluding adjacent
towns and local trips)
= 1,500
= 10,500
New Hampshire
Local Trips: 17,386
Adjacent Trips: 13,452
Total Trips: 81,713

Sector	Residence	Work in Burlington	Work in Wilmington	Work in Woburn	Combined
Local	Burlington	3,657	275	1,205	5,137
Local	Wilmington	579	2,567	721	3,867
Local	Woburn	1,884	547	5,951	8,382
	Total				17,386
Adjacent	Bedford	413	32	121	566
Adjacent	Billerica	1,999	758	743	3,500
Adjacent	Lexington	906	134	199	1,239
Adjacent	North Reading	220	371	466	1,057
Adjacent	Reading	578	399	1,020	1,997
Adjacent	Stoneham	461	253	808	1,522
Adjacent	Tewksbury	760	1,064	530	2,354
Adjacent	Winchester	431	143	643	1,217
	Total				13,452
W	Acton	219	72	98	389
W	Ayer	27	35	41	103
W	Berlin	-	2	4	6
W	Bolton	17	16	-	33
W	Boxborough	32	28	5	65
W	Carlisle	119	-	33	152
W	Clinton	28	8	24	60
W	Concord	192	18	59	269
W	Fitchburg	51	28	21	100
W	Gardner	-	6	21	27
W	Groton	44	26	6	76
W	Harvard	5	21	-	26
W	Holden	28	6	19	53
W	Hudson	91	26	33	150
W	Lancaster	-	-	16	16
W	Leominster	114	15	38	167
W	Littleton	69	25	25	119
W	Lunenburg	41	13	9	63
W	Maynard	57	-	20	77
W	Shirley	4	23	5	32
W	Sterling	8	18	-	26
W	Stow	17	5	16	38
W	Templeton	17	-	-	17
W	Townsend	33	7	17	57
	Total				2,121
SW	Ashland	104	15	9	128
SW	Auburn	14	-	-	14
SW	Bellingham	9	22	18	49
SW	Blackstone	7	7	-	14
SW	Charlton	8	10	9	27
SW	Douglas	8	-	-	8
SW	Dudley	-	-	7	7
SW	Framingham	309	70	115	494
SW	Franklin	50	18	12	80
SW	Grafton	6	7	15	28
SW	Holliston	32	24	44	100
SW	Hopedale	9	10	11	30
SW	Hopkinton	25	-	27	52
SW	Lincoln	85	14	23	122
SW	Marlborough	68	25	48	141
SW	Medway	21	12	27	60
SW	Mendon	5	-	-	5
SW	Milford	33	32	15	80
SW	Millbury	10	-	14	24
SW	Millis	39	17	8	64
SW	Natick	83	68	106	257
SW	Northborough	41	45	15	101
SW	Northbridge	-	5	-	5
SW	Oxford	-	-	7	7

Sector	Residence	Work in Burlington	Work in Wilmington	Work in Woburn	Combined
SW	Sherborn	13	5	-	18
SW	Shrewsbury	34	-	-	34
SW	Southborough	12	-	14	26
SW	Southbridge	-	9	-	9
SW	Sturbridge	13	-	-	13
SW	Sudbury	124	26	74	224
SW	Upton	-	9	6	15
SW	Uxbridge	26	-	-	26
SW	Waltham	572	141	340	1,053
SW	Wayland	78	43	45	166
SW	Webster	-	13	-	13
SW	Wellesley	162	42	35	239
SW	Westborough	54	7	-	61
SW	Weston	64	33	21	118
SW	Worcester	32	31	35	98
	Total				4,010
S	Abington	6	19	34	59
S	Arlington	731	150	513	1,394
S	Attleboro	32	-	-	32
S	Avon	-	-	14	14
S	Belmont	221	42	137	400
S	Berkley	-	-	6	6
S	Boston	1,164	416	1,272	2,852
S	Bridgewater	-	9	23	32
S	Brockton	134	52	162	348
S	Brookline	188	77	121	386
S	Cambridge	337	103	265	705
S	Canton	24	19	17	60
S	Dartmouth	-	10	11	21
S	Dedham	46	38	26	110
S	Dover	24	46	17	87
S	East Bridgewater	-	-	12	12
S	Easton	17	10	45	72
S	Fall River	-	-	14	14
S	Foxborough	11	10	33	54
S	Holbrook	9	11	27	47
S	Lakeville	9	-	17	26
S	Mansfield	30	7	9	46
S	Medfield	14	41	10	65
S	Middleborough	6	7	-	13
S	Milton	22	37	17	76
S	Needham	123	14	33	170
S	New Bedford	7	13	5	25
S	Newton	422	94	253	769
S	Norfolk	12	9	16	37
S	North Attleborough	16	16	15	47
S	Norton	-	-	25	25
S	Norwood	92	38	58	188
S	Plainville	8	9	-	17
S	Randolph	70	17	33	120
S	Rhode Island	64	62	74	200
S	Sharon	52	-	17	69
S	Somerset	11	-	-	11
S	Somerville	400	142	640	1,182
S	Stoughton	49	14	30	93
S	Swansea	-	-	6	6
S	Taunton	9	16	8	33
S	Walpole	54	34	31	119
S	Watertown	246	75	223	544
S	West Bridgewater	22	12	9	43
S	Westwood	34	8	20	62
S	Wrentham	8	-	22	30
	Total				10,721

Sector	Residence	Work in Burlington	Work in Wilmington	Work in Woburn	Combined
SE	Barnstable	11	-	37	48
SE	Bourne	14	10	10	34
SE	Braintree	91	41	99	231
SE	Carver	18	12	-	30
SE	Chelsea	56	58	222	336
SE	Cohasset	16	18	8	42
SE	Duxbury	-	6	7	13
SE	Everett	224	181	433	838
SE	Falmouth	-	7	-	7
SE	Halifax	-	7	-	7
SE	Hanover	23	13	24	60
SE	Hanson	-	-	13	13
SE	Hingham	6	32	29	67
SE	Hull	10	-	22	32
SE	Malden	458	253	622	1,333
SE	Marshfield	20	7	38	65
SE	Medford	628	338	789	1,755
SE	Melrose	287	254	639	1,180
SE	Norwell	19	6	6	31
SE	Pembroke	5	6	25	36
SE	Plymouth	44	17	54	115
SE	Plympton	-	-	2	2
SE	Quincy	64	30	75	169
SE	Revere	134	117	304	555
SE	Rockland	-	7	7	14
SE	Sandwich	8	-	-	8
SE	Scituate	29	-	-	29
SE	Wareham	8	15	27	50
SE	Weymouth	125	19	83	227
SE	Whitman	7	-	-	7
SE	Winthrop	109	8	88	205
SE	Yarmouth	-	-	7	7
	Total				7,546
E	Beverly	201	264	191	656
E	Danvers	141	113	171	425
E	Essex	21	-	-	21
E	Gloucester	41	49	109	199
E	Hamilton	41	-	14	55
E	Lynn	181	365	525	1,071
E	Lynnfield	243	191	181	615
E	Manchester	16	15	41	72
E	Marblehead	145	56	149	350
E	Nahant	21	31	25	77
E	Peabody	275	348	491	1,114
E	Rockport	79	56	32	167
E	Salem	207	147	224	578
E	Saugus	226	157	297	680
E	Swampscott	58	42	118	218
E	Wakefield	305	202	709	1,216
E	Wenham	26	25	6	57
	Total				7,571
NE	Amesbury	61	14	41	116
NE	Boxford	57	68	34	159
NE	Dover NH	-	7	-	7
NE	Durham	6	-	-	6
NE	E Kingston	4	9	2	15
NE	Exeter	24	8	8	40
NE	Georgetown	6	35	63	104
NE	Greenland	-	10	-	10
NE	Groveland	5	48	26	79
NE	Hampton	16	20	19	55
NE	Hampton Falls	-	-	2	2
NE	Ipswich	72	34	41	147

Sector	Residence	Work in Burlington	Work in Wilmington	Work in Woburn	Combined
NE	Merrimac	5	29	54	88
NE	Middleton	23	31	80	134
NE	Newbury	28	33	55	116
NE	Newburyport	73	22	111	206
NE	Newmarket	-	8	-	8
NE	North Hampton	17	-	-	17
NE	Portsmouth	-	24	39	63
NE	Rowley	29	14	36	79
NE	Salisbury	18	56	6	80
NE	Seabrook	-	25	20	45
NE	Stratham	8	33	-	41
NE	Topsfield	72	26	99	197
NE	West Newbury	25	6	19	50
	Total				1,864
N	Andover	357	584	307	1,248
N	Atkinson	-	47	13	60
N	Danville	10	25	2	37
N	Derry	111	405	267	783
N	Epping	-	7	-	7
N	Hampstead	48	77	64	189
N	Haverhill	330	455	301	1,086
N	Kingston NH	14	27	31	72
N	Lawrence	230	745	311	1,286
N	Methuen	162	563	210	935
N	Newton NH	17	27	22	66
N	North Andover	126	407	195	728
N	Plaistow	34	65	44	143
N	Raymond	16	11	18	45
N	Salem NH	181	371	209	761
N	Sandown	12	30	13	55
	Total				7,501
NW	Amherst	34	-	7	41
NW	Bedford NH	8	15	19	42
NW	Brookline NH	6	4	-	10
NW	Chelmsford	730	370	227	1,327
NW	Dracut	354	337	243	934
NW	Dunstable	28	23	11	62
NW	Goffstown	15	34	8	57
NW	Hollis	29	6	-	35
NW	Hooksett	5	-	-	5
NW	Hudson NH	104	102	61	267
NW	Litchfield	20	28	18	66
NW	Londonderry	74	266	150	490
NW	Lowell	1,137	1,106	676	2,919
NW	Manchester NH	91	101	116	308
NW	Mason	7	3	-	10
NW	Merrimack	190	56	53	299
NW	Milford NH	10	-	10	20
NW	Nashua	813	279	245	1,337
NW	Pelham	54	102	44	200
NW	Pepperell	101	69	50	220
NW	Tyngsborough	144	88	66	298
NW	Westford	188	109	111	408
NW	Windham	103	66	17	186
	Total				9,541
	Grand Total	31,058	20,471	30,184	81,713


New Hampshire
1990
Commuting
Flows
to Needham,
Newton and
Wellesley
by Sector
(excluding adjacent
towns and local trips)
= 2,000
= 7,000
Local Trips: 22,337
Adjacent Trips: 20,326
Total Trips: 77,045
Rhode Island

Sector	Residence	Work in Needham	Work in Newton	Work in Wellesley	Combined
Local	Needham	3,308	1,121	684	5,113
Local	Newton	1,000	10,505	1,062	12,567
Local	Wellesley	220	624	3,813	4,657
	Total				22,337
Adjacent	Boston	1,736	6,951	1,371	10,058
Adjacent	Brookline	175	1,334	274	1,783
Adjacent	Dedham	478	563	138	1,179
Adjacent	Dover	126	91	70	287
Adjacent	Natick	395	705	1,270	2,370
Adjacent	Waltham	450	1,576	437	2,463
Adjacent	Watertown	181	841	285	1,307
Adjacent	Wayland	73	208	95	376
Adjacent	Weston	54	261	188	503
	Total				20,326
W	Amherst	14	23	-	37
W	Ashland	135	168	195	498
W	Auburn	16	29	20	65
W	Berlin	7	17	-	24
W	Boylston	-	5	-	5
W	Clinton	-	13	-	13
W	Framingham	442	954	1,107	2,503
W	Grafton	19	41	17	77
W	Holden	9	16	5	30
W	Hopkinton	41	139	87	267
W	Hudson	88	84	61	233
W	Marlborough	168	312	163	643
W	Millbury	-	7	14	21
W	Northborough	30	80	51	161
W	Oxford	17	-	30	47
W	Shrewsbury	8	38	24	70
W	Southborough	46	44	33	123
W	Sterling	-	9	-	9
W	Sturbridge	6	-	7	13
W	Westborough	38	54	50	142
W	Worcester	102	74	42	218
	Total				5,199
SW	Bellingham	68	167	46	281
SW	Blackstone	38	31	14	83
SW	Douglas	8	-	12	20
SW	Dudley	-	6	-	6
SW	Holliston	196	287	295	778
SW	Hopedale	21	8	48	77
SW	Medway	137	133	141	411
SW	Mendon	17	15	7	39
SW	Milford	111	109	97	317
SW	Northbridge	35	7	23	65
SW	Sherborn	43	101	109	253
SW	Southbridge	8	31	5	44
SW	Sutton	-	8	-	8
SW	Upton	6	7	29	42
SW	Uxbridge	-	72	4	76
	Total				2,500
S	Attleboro	111	60	20	191
S	Berkley	-	22	-	22
S	Dartmouth	33	8	17	58
S	Dighton	-	7	12	19
S	Easton	54	137	63	254
S	Fall River	21	23	11	55
S	Foxborough	65	74	33	172

Sector	Residence	Work in Needham	Work in Newton	Work in Wellesley	Combined
S	Franklin	161	143	282	586
S	Freetown	11	7	-	18
S	Mansfield	80	91	16	187
S	Medfield	255	214	170	639
S	Millis	150	129	183	462
S	New Bedford	22	82	26	130
S	Norfolk	88	66	114	268
S	North Attleborough	69	141	32	242
S	Norton	42	77	6	125
S	Norwood	469	479	141	1,089
S	Plainville	84	30	17	131
S	Rhode Island	315	388	117	820
S	Seekonk	4	-	7	11
S	Sharon	145	172	49	366
S	Somerset	9	10	9	28
S	Taunton	62	124	23	209
S	Walpole	250	233	80	563
S	Wrentham	106	39	26	171
	Total				6,816
SE	Abington	31	49	14	94
SE	Acushnet	-	6	-	6
SE	Avon	11	29	6	46
SE	Barnstable	7	66	8	81
SE	Bourne	6	14	6	26
SE	Bridgewater	60	117	6	183
SE	Brockton	306	338	106	750
SE	Canton	152	215	89	456
SE	Carver	27	17	12	56
SE	Duxbury	6	71	14	91
SE	East Bridgewater	6	28	-	34
SE	Falmouth	17	33	7	57
SE	Halifax	-	8	-	8
SE	Hanover	6	26	14	46
SE	Hanson	43	16	-	59
SE	Holbrook	39	94	11	144
SE	Kingston	21	35	-	56
SE	Lakeville	7	19	-	26
SE	Mashpee	-	12	5	17
SE	Middleborough	-	22	-	22
SE	Pembroke	43	42	9	94
SE	Plymouth	46	99	31	176
SE	Plympton	-	5	2	7
SE	Randolph	192	226	31	449
SE	Raynham	21	17	18	56
SE	Rochester	5	6	-	11
SE	Rockland	56	65	9	130
SE	Sandwich	-	-	18	18
SE	Stoughton	102	239	82	423
SE	Wareham	16	10	6	32
SE	West Bridgewater	33	23	-	56
SE	Westwood	259	228	135	622
SE	Whitman	7	21	11	39
SE	Yarmouth	7	-	-	7
	Total				4,378
E	Braintree	149	189	98	436
E	Cambridge	135	713	295	1,143
E	Chelsea	63	48	-	111
E	Cohasset	-	22	17	39
E	Everett	24	122	88	234
E	Hingham	59	33	31	123
E	Hull	25	41	-	66

Sector	Residence	Work in Needham	Work in Newton	Work in Wellesley	Combined
E	Marshfield	29	108	34	171
E	Milton	39	242	62	343
E	Norwell	65	49	22	136
E	Quincy	286	391	176	853
E	Revere	6	172	5	183
E	Scituate	-	111	12	123
E	Somerville	175	657	101	933
E	Weymouth	205	279	116	600
E	Winthrop	-	49	35	84
	Total				5,578
NE	Amesbury	6	10	-	16
NE	Arlington	104	397	117	618
NE	Belmont	50	301	94	445
NE	Beverly	72	64	52	188
NE	Boxford	-	12	17	29
NE	Danvers	9	70	-	79
NE	Dover NH	-	9	6	15
NE	Durham	-	4	-	4
NE	E Kingston	-	6	-	6
NE	Essex	-	10	9	19
NE	Exeter	-	-	10	10
NE	Georgetown	7	-	-	7
NE	Gloucester	25	53	6	84
NE	Greenland	7	8	-	15
NE	Groveland	-	7	-	7
NE	Hamilton	8	-	9	17
NE	Hampton	-	11	15	26
NE	Hampton Falls	4	-	-	4
NE	Haverhill	-	43	14	57
NE	Ipswich	7	5	38	50
NE	Lynn	65	120	23	208
NE	Lynnfield	16	17	19	52
NE	Maine	7	40	58	105
NE	Malden	51	129	44	224
NE	Manchester	-	10	-	10
NE	Marblehead	35	23	18	76
NE	Medford	99	287	88	474
NE	Melrose	72	122	45	239
NE	Middleton	6	-	25	31
NE	Nahant	-	12	-	12
NE	Newbury	-	9	-	9
NE	Newburyport	-	11	-	11
NE	Newmarket	-	-	15	15
NE	Newton NH	6	7	-	13
NE	North Andover	-	58	35	93
NE	North Hampton	7	-	6	13
NE	North Reading	11	15	19	45
NE	Peabody	54	48	7	109
NE	Portsmouth	11	-	6	17
NE	Reading	32	133	32	197
NE	Rockport	-	30	-	30
NE	Rowley	-	-	8	8
NE	Salem	64	89	24	177
NE	Saugus	35	18	26	79
NE	Stoneham	-	103	83	186
NE	Swampscott	13	27	14	54
NE	Topsfield	5	19	5	29
NE	Wakefield	13	77	71	161
NE	Wenham	-	17	5	22
NE	West Newbury	6	7	-	13
NE	Winchester	70	77	86	233

Sector	Residence	Work in Needham	Work in Newton	Work in Wellesley	Combined
NE	Woburn	37	181	65	283
	Total				4,924
N	Andover	34	77	13	124
N	Atkinson	9	6	7	22
N	Bedford	40	67	17	124
N	Billerica	175	132	36	343
N	Burlington	87	186	49	322
N	Chelmsford	48	61	33	142
N	Concord NH	-	13	-	13
N	Danville	-	2	-	2
N	Derry	21	7	13	41
N	Dracut	38	13	22	73
N	Epping	-	7	-	7
N	Hudson NH	17	35	24	76
N	Lawrence	12	76	29	117
N	Lexington	127	255	115	497
N	Londonderry	7	12	-	19
N	Lowell	71	230	45	346
N	Manchester NH	37	38	9	84
N	Methuen	-	41	16	57
N	Pelham	-	23	-	23
N	Salem NH	8	37	7	52
N	Tewksbury	45	89	53	187
N	Wilmington	21	83	6	110
N	Windham	9	-	8	17
	Total				2,798
NW	Acton	59	76	86	221
NW	Amherst NH	-	11	-	11
NW	Bedford NH	-	4	-	4
NW	Bolton	4	39	7	50
NW	Boxborough	11	19	17	47
NW	Brookline NH	-	2	-	2
NW	Carlisle	15	44	5	64
NW	Concord	78	52	77	207
NW	Dunstable	2	3	-	5
NW	Fitchburg	27	17	6	50
NW	Gardner	15	7	-	22
NW	Groton	-	11	9	20
NW	Harvard	-	14	13	27
NW	Hollis	-	14	5	19
NW	Leominster	5	62	-	67
NW	Lincoln	43	48	6	97
NW	Littleton	16	30	14	60
NW	Lunenburg	-	-	18	18
NW	Mason	-	-	3	3
NW	Maynard	113	163	20	296
NW	Merrimack	15	8	10	33
NW	Nashua	55	83	80	218
NW	Pepperell	-	31	9	40
NW	Shirley	-	33	7	40
NW	Stow	-	34	14	48
NW	Sudbury	130	203	73	406
NW	Townsend	-	10	-	10
NW	Tyngsborough	10	23	-	33
NW	Westford	30	27	6	63
NW	Westminster	8	-	-	8
	Total				2,189
	Grand Total	17,924	41,301	17,820	77,045

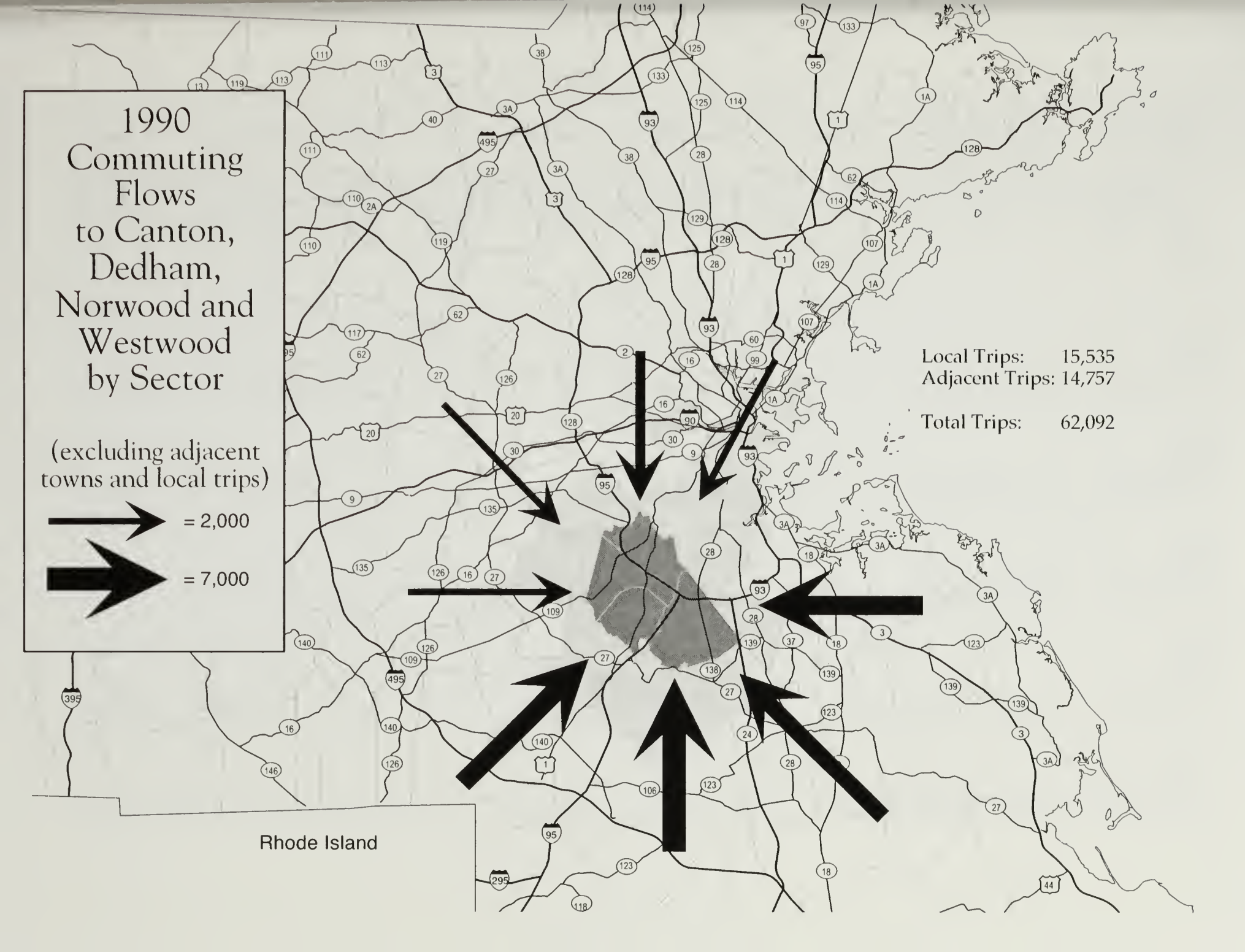

1990
Commuting
Flows
to Braintree
and Quincy
by Sector
(excluding adjacent
towns and local trips)
= 3,000
= 7,000
Local Trips: 20,906
Adjacent Trips: 16,806
Total Trips: 66,685
Rhode Island

Sector	Residence	Work in Braintree	Work in Quincy	Combined
Local	Braintree	2,062	2,116	4,178
Local	Quincy	3,088	13,640	16,728
	Total			20,906
Adjacent	Boston	2,062	3,885	5,947
Adjacent	Holbrook	651	317	968
Adjacent	Milton	486	1,099	1,585
Adjacent	Randolph	1,363	837	2,200
Adjacent	Weymouth	2,734	3,372	6,106
	Total			16,806
W	Ashland	28	32	60
W	Auburn	21	7	28
W	Bellingham	29	13	42
W	Blackstone	8	-	8
W	Canton	237	275	512
W	Douglas	-	5	5
W	Dover	46	20	66
W	Framingham	105	151	256
W	Franklin	59	70	129
W	Holliston	22	17	39
W	Hopkinton	36	-	36
W	Marlborough	23	39	62
W	Medfield	53	29	82
W	Medway	7	21	28
W	Mendon	8	-	8
W	Milford	17	-	17
W	Millbury	-	6	6
W	Millis	39	50	89
W	Natick	91	94	185
W	Norfolk	41	21	62
W	Northborough	22	-	22
W	Northbridge	14	14	28
W	Norwood	160	140	300
W	Sherborn	-	21	21
W	Shrewsbury	13	7	20
W	Southborough	11	-	11
W	Sturbridge	11	-	11
W	Upton	-	7	7
W	Uxbridge	8	9	17
W	Walpole	86	134	220
W	Westborough	-	16	16
W	Westwood	112	83	195
W	Worcester	73	59	132
	Total			2,720
SW	Attleboro	75	123	198
SW	Easton	319	164	483
SW	Foxborough	100	110	210
SW	Mansfield	137	119	256
SW	North Attleborough	149	82	231
SW	Norton	51	15	66
SW	Plainville	48	14	62
SW	Rehoboth	6	-	6
SW	Rhode Island	282	249	531
SW	Seekonk	28	-	28
SW	Sharon	217	174	391

Sector	Residence	Work in Braintree	Work in Quincy	Combined
SW	Stoughton	303	471	774
SW	Wrentham	43	59	102
	Total			3,338
S	Avon	95	97	192
S	Berkley	6	7	13
S	Bridgewater	225	157	382
S	Brockton	1,165	1,053	2,218
S	Dartmouth	39	-	39
S	Dighton	14	9	23
S	East Bridgewater	169	157	326
S	Fairhaven	10	5	15
S	Fall River	72	59	131
S	Freetown	9	16	25
S	Lakeville	88	34	122
S	Middleborough	32	98	130
S	New Bedford	116	35	151
S	Raynham	38	77	115
S	Somerset	-	25	25
S	Swansea	12	66	78
S	Taunton	222	262	484
S	West Bridgewater	61	58	119
	Total			4,588
SE	Abington	466	365	831
SE	Barnstable	24	14	38
SE	Bourne	14	28	42
SE	Carver	102	78	180
SE	Duxbury	272	325	597
SE	Falmouth	68	27	95
SE	Halifax	91	100	191
SE	Hanover	325	342	667
SE	Hanson	207	163	370
SE	Kingston	155	132	287
SE	Mashpee	28	13	41
SE	Pembroke	371	361	732
SE	Plymouth	510	371	881
SE	Plympton	25	21	46
SE	Rockland	445	408	853
SE	Sandwich	21	23	44
SE	Wareham	61	53	114
SE	Whitman	342	271	613
SE	Yarmouth	-	27	27
	Total			6,649
E	Cohasset	197	233	430
E	Hingham	474	921	1,395
E	Hull	305	516	821
E	Marshfield	420	609	1,029
E	Norwell	203	211	414
E	Scituate	316	421	737
	Total			4,826
N	Salem NH	16	5	21
N	Amesbury	16	19	35
N	Andover	6	35	41
N	Beverly	41	41	82

Sector	Residence	Work in Braintree	Work in Quincy	Combined
N	Boxford	-	23	23
N	Cambridge	222	216	438
N	Chelsea	14	77	91
N	Danvers	29	18	47
N	E Kingston	-	2	2
N	Essex	8	-	8
N	Everett	41	69	110
N	Exeter	10	7	17
N	Georgetown	23	-	23
N	Gloucester	14	13	27
N	Hamilton	-	6	6
N	Haverhill	18	37	55
N	Ipswich	16	6	22
N	Lawrence	6	15	21
N	Lynn	87	104	191
N	Lynnfield	26	19	45
N	Maine	17	26	43
N	Malden	70	174	244
N	Manchester	24	10	34
N	Marblehead	47	27	74
N	Medford	48	97	145
N	Melrose	25	107	132
N	Merrimac	6	-	6
N	Methuen	5	-	5
N	Middleton	6	6	12
N	Nahant	28	-	28
N	Newburyport	10	25	35
N	North Andover	-	29	29
N	North Reading	30	31	61
N	Peabody	161	46	207
N	Raymond	-	12	12
N	Reading	26	23	49
N	Revere	46	107	153
N	Rowley	-	12	12
N	Rye	-	8	8
N	Salem	21	54	75
N	Salisbury	26	-	26
N	Saugus	15	55	70
N	Seabrook	-	14	14
N	Somerville	127	208	335
N	Stoneham	26	46	72
N	Swampscott	9	37	46
N	Topsfield	7	11	18
N	Wakefield	33	61	94
N	Wenham	8	-	8
N	Wilmington	27	32	59
N	Winchester	18	36	54
N	Winthrop	13	35	48
N	Woburn	62	38	100
	Total			3,613
NW	Acton	4	18	22
NW	Arlington	55	107	162
NW	Bedford	9	-	9
NW	Belmont	58	113	171
NW	Billerica	13	37	50
NW	Brookline	146	291	437

Sector	Residence	Work in Braintree	Work in Quincy	Combined
NW	Burlington	48	15	63
NW	Chelmsford	33	-	33
NW	Clinton	-	20	20
NW	Concord	71	37	108
NW	Dedham	109	215	324
NW	Dracut	9	32	41
NW	Fitchburg	-	6	6
NW	Gardner	-	9	9
NW	Harvard	-	9	9
NW	Hudson	-	11	11
NW	Hudson NH	7	21	28
NW	Leominster	6	-	6
NW	Lexington	23	47	70
NW	Lincoln	5	-	5
NW	Litchfield	7	-	7
NW	Littleton	8	16	24
NW	Londonderry	9	-	9
NW	Lowell	3	49	52
NW	Manchester NH	-	11	11
NW	Maynard	10	6	16
NW	Merrimack	-	6	6
NW	Nashua	-	37	37
NW	Needham	111	102	213
NW	Newton	155	313	468
NW	Pelham	-	5	5
NW	Stow	-	17	17
NW	Sudbury	13	22	35
NW	Templeton	-	5	5
NW	Tewksbury	17	32	49
NW	Waltham	113	107	220
NW	Watertown	84	171	255
NW	Wayland	19	-	19
NW	Wellesley	49	111	160
NW	Westford	13	7	20
NW	Weston	19	-	19
NW	Windham	8	-	8
	Total			3,239
	Grand Total	26,167	40,518	66,685

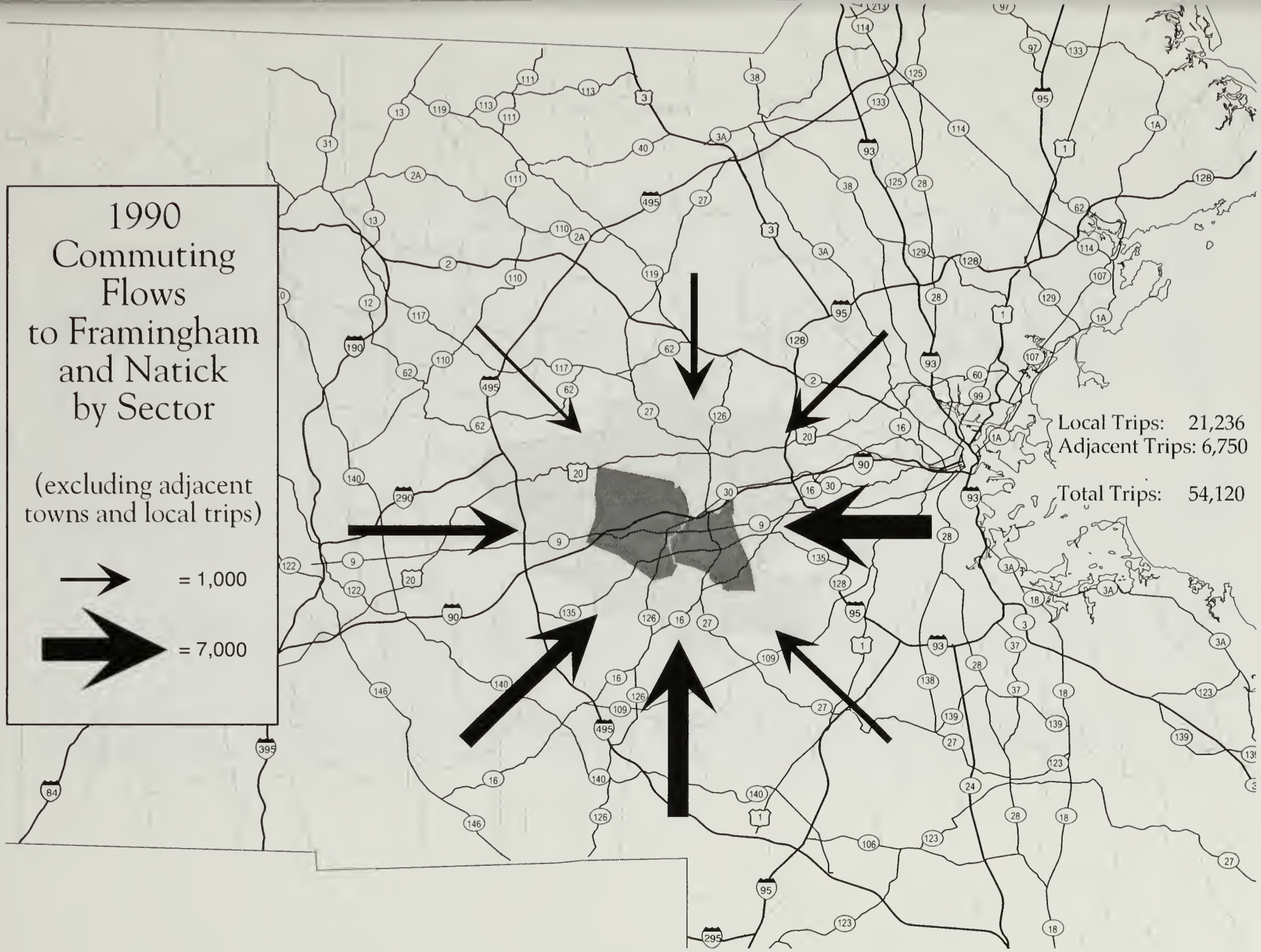

1990
Commuting
Flows
to Canton,
Dedham,
Norwood and
Westwood
by Sector
(excluding adjacent
towns and local trips)
= 2,000
= 7,000
Local Trips: 15,535
Adjacent Trips: 14,757
Total Trips: 62,092
Rhode Island

Sector	Residence	Work in Canton	Work in Dedham	Work in Norwood	Work in Westwood	Combined
Local	Canton	2,299	266	556	234	3,355
Local	Dedham	294	2,700	638	308	3,940
Local	Norwood	437	758	4,346	663	6,204
Local	Westwood	103	447	531	955	2,036
	Total					15,535
Adjacent	Boston	1,016	2,468	1,952	861	6,297
Adjacent	Dover	20	43	113	36	212
Adjacent	Milton	175	189	105	37	506
Adjacent	Needham	67	227	134	89	517
Adjacent	Randolph	510	202	290	89	1,091
Adjacent	Sharon	497	201	515	164	1,377
Adjacent	Stoughton	1,216	246	779	91	2,332
Adjacent	Walpole	244	355	1,626	200	2,425
	Total					14,757
W	Ashland	9	-	25	16	50
W	Boylston	-	5	-	-	5
W	Douglas	10	5	7	-	22
W	Dudley	8	-	-	-	8
W	Grafton	-	19	-	8	27
W	Holliston	37	22	28	41	128
W	Hopedale	6	15	13	5	39
W	Hopkinton	-	16	18	-	34
W	Medfield	81	61	248	122	512
W	Medway	26	50	105	43	224
W	Millis	36	77	139	125	377
W	Northborough	-	5	46	-	51
W	Northbridge	21	-	13	21	55
W	Oxford	-	8	-	-	8
W	Sherborn	-	6	27	6	39
W	Shrewsbury	28	11	4	7	50
W	Southborough	-	16	6	-	22
W	Sutton	-	16	7	-	23
W	Upton	-	8	8	-	16
W	Webster	-	7	8	-	15
W	West Boylston	-	-	7	-	7
W	Westborough	12	-	30	18	60
W	Worcester	40	57	64	6	167
	Total					1,939
SW	Bellingham	77	18	187	39	321
SW	Blackstone	8	-	37	-	45
SW	Franklin	88	121	351	118	678
SW	Mendon	13	-	6	-	19
SW	Norfolk	76	106	274	104	560
SW	North Attleborough	225	108	515	177	1,025
SW	Plainville	49	24	256	15	344
SW	Rhode Island	657	250	811	369	2,087
SW	Uxbridge	-	-	24	21	45
SW	Wrentham	96	63	330	55	544
	Total					5,668
S	Attleboro	200	104	497	62	863
S	Berkley	11	-	17	-	28
S	Dartmouth	18	25	17	15	75
S	Dighton	16	-	7	6	29

Sector	Residence	Work in Canton	Work in Dedham	Work in Norwood	Work in Westwood	Combined
S	Easton	408	69	189	77	743
S	Fairhaven	10	5	11	15	41
S	Fall River	151	12	60	20	243
S	Foxborough	303	193	586	141	1,223
S	Freetown	53	-	32	9	94
S	Lakeville	108	-	33	-	141
S	Mansfield	248	179	549	152	1,128
S	New Bedford	79	45	60	29	213
S	Norton	238	76	294	45	653
S	Raynham	52	37	38	-	127
S	Rehoboth	7	-	41	-	48
S	Seekonk	16	-	51	-	67
S	Somerset	30	7	16	9	62
S	Swansea	25	-	11	-	36
S	Taunton	315	132	221	79	747
	Total					6,561
SE	Acushnet	-	-	6	-	6
SE	Avon	103	17	32	10	162
SE	Barnstable	18	22	11	-	51
SE	Bourne	16	-	7	14	37
SE	Bridgewater	217	88	91	35	431
SE	Brockton	1,220	261	512	250	2,243
SE	Carver	91	24	29	28	172
SE	East Bridgewater	121	26	43	12	202
SE	Falmouth	7	12	18	10	47
SE	Halifax	49	7	8	8	72
SE	Hanson	32	31	40	6	109
SE	Kingston	13	19	31	7	70
SE	Mashpee	-	18	-	-	18
SE	Middleborough	85	32	6	35	158
SE	Plymouth	42	112	60	34	248
SE	Plympton	5	2	-	2	9
SE	Rochester	4	-	15	-	19
SE	Sandwich	23	12	6	17	58
SE	Wareham	58	15	25	-	98
SE	West Bridgewater	70	17	41	29	157
SE	Whitman	129	50	66	24	269
SE	Yarmouth	12	-	-	-	12
	Total					4,648
E	Abington	145	38	50	9	242
E	Braintree	249	111	253	66	679
E	Cohasset	9	10	8	-	27
E	Duxbury	35	32	55	24	146
E	Hanover	40	40	81	40	201
E	Hingham	110	89	127	64	390
E	Holbrook	87	72	36	56	251
E	Hull	88	46	38	28	200
E	Marshfield	134	62	97	116	409
E	Norwell	52	46	50	7	155
E	Pembroke	78	53	33	32	196
E	Quincy	511	364	332	218	1,425
E	Rockland	89	39	49	15	192
E	Scituate	62	37	30	24	153
E	Weymouth	356	227	235	95	913
	Total					5,579

Sector	Residence	Work in Canton	Work in Dedham	Work in Norwood	Work in Westwood	Combined
NE	Amesbury	-	-	-	9	9
NE	Beverly	33	11	10	-	54
NE	Boxford	-	7	9	-	16
NE	Brookline	57	119	55	25	256
NE	Cambridge	72	72	70	42	256
NE	Chelsea	-	38	9	10	57
NE	Danvers	9	8	25	-	42
NE	Essex	-	-	7	-	7
NE	Everett	-	15	-	19	34
NE	Exeter	-	7	9	-	16
NE	Georgetown	-	-	12	15	27
NE	Greenland	7	6	-	-	13
NE	Hamilton	6	-	22	-	28
NE	Hampton	-	-	10	-	10
NE	Ipswich	8	-	-	6	14
NE	Lynn	-	11	59	36	106
NE	Lynnfield	26	-	12	13	51
NE	Maine	16	26	25	3	70
NE	Malden	21	43	45	5	114
NE	Marblehead	11	24	9	-	44
NE	Medford	22	20	109	28	179
NE	Melrose	17	16	10	21	64
NE	Middleton	-	-	8	-	8
NE	Nahant	-	6	-	-	6
NE	Newbury	-	-	-	10	10
NE	Peabody	13	24	8	-	45
NE	Portsmouth	-	-	-	5	5
NE	Revere	31	7	64	-	102
NE	Rowley	12	-	-	-	12
NE	Salem	12	8	10	6	36
NE	Saugus	26	24	-	19	69
NE	Somerville	71	41	44	6	162
NE	Stoneham	-	50	3	3	56
NE	Swampscott	20	9	9	8	46
NE	Wakefield	-	27	15	-	42
NE	Wenham	-	6	6	-	12
NE	Winthrop	-	12	15	-	27
	Total					2,105
N	Andover	13	-	7	6	26
N	Arlington	86	65	72	28	251
N	Atkinson	12	-	-	-	12
N	Auburn	6	-	26	6	38
N	Bedford	-	-	19	18	37
N	Belmont	34	15	41	38	128
N	Billerica	-	19	42	21	82
N	Burlington	25	15	30	11	81
N	Chelmsford	27	9	8	26	70
N	Concord NH	13	-	-	-	13
N	Derry	-	-	14	9	23
N	Dracut	-	-	9	-	9
N	Haverhill	8	8	18	-	34
N	Kingston NH	-	5	-	-	5
N	Lawrence	-	10	-	14	24
N	Lexington	37	14	74	34	159
N	Londonderry	-	-	7	6	13
N	Lowell	19	24	18	22	83

Sector	Residence	Work in Canton	Work in Dedham	Work in Norwood	Work in Westwood	Combined
N	Manchester NH	7	-	-	9	16
N	Methuen	-	8	-	-	8
N	Newton	186	271	178	133	768
N	North Andover	23	9	4	-	36
N	North Reading	13	-	25	6	44
N	Reading	16	15	23	-	54
N	Salem NH	-	7	27	8	42
N	Tewksbury	43	27	6	25	101
N	Waltham	81	96	182	80	439
N	Watertown	18	54	79	32	183
N	Wilmington	6	-	30	6	42
N	Winchester	30	19	23	21	93
N	Windham	-	-	-	7	7
N	Woburn	26	42	41	15	124
	Total					3,045
NW	Acton	14	11	13	24	62
NW	Ayer	-	-	-	8	8
NW	Bolton	-	-	6	-	6
NW	Brookline NH	2	-	-	-	2
NW	Carlisle	-	-	5	-	5
NW	Clinton	4	-	-	8	12
NW	Concord	16	-	6	-	22
NW	Dunstable	2	-	-	-	2
NW	Fitchburg	18	-	-	-	18
NW	Framingham	191	151	118	86	546
NW	Gardner	-	-	-	6	6
NW	Harvard	6	-	17	-	23
NW	Hollis	7	-	-	-	7
NW	Hudson	14	8	39	8	69
NW	Hudson NH	9	6	6	19	40
NW	Lancaster	-	-	-	7	7
NW	Leominster	-	-	-	9	9
NW	Lincoln	8	7	-	11	26
NW	Lunenburg	-	-	-	8	8
NW	Marlborough	47	27	51	8	133
NW	Maynard	12	-	12	-	24
NW	Merrimack	-	-	-	8	8
NW	Milford	25	16	100	28	169
NW	Nashua	12	12	45	-	69
NW	Natick	73	92	128	132	425
NW	Pepperell	-	10	-	-	10
NW	Sterling	-	-	8	-	8
NW	Sudbury	14	6	23	25	68
NW	Tyngsborough	12	-	-	13	25
NW	Wayland	24	-	59	15	98
NW	Wellesley	38	50	100	6	194
NW	Westford	12	-	7	-	19
NW	Westminster	11	-	-	-	11
NW	Weston	-	-	76	40	116
	Total					2,255
	Grand Total	16,919	13,876	22,941	8,356	62,092

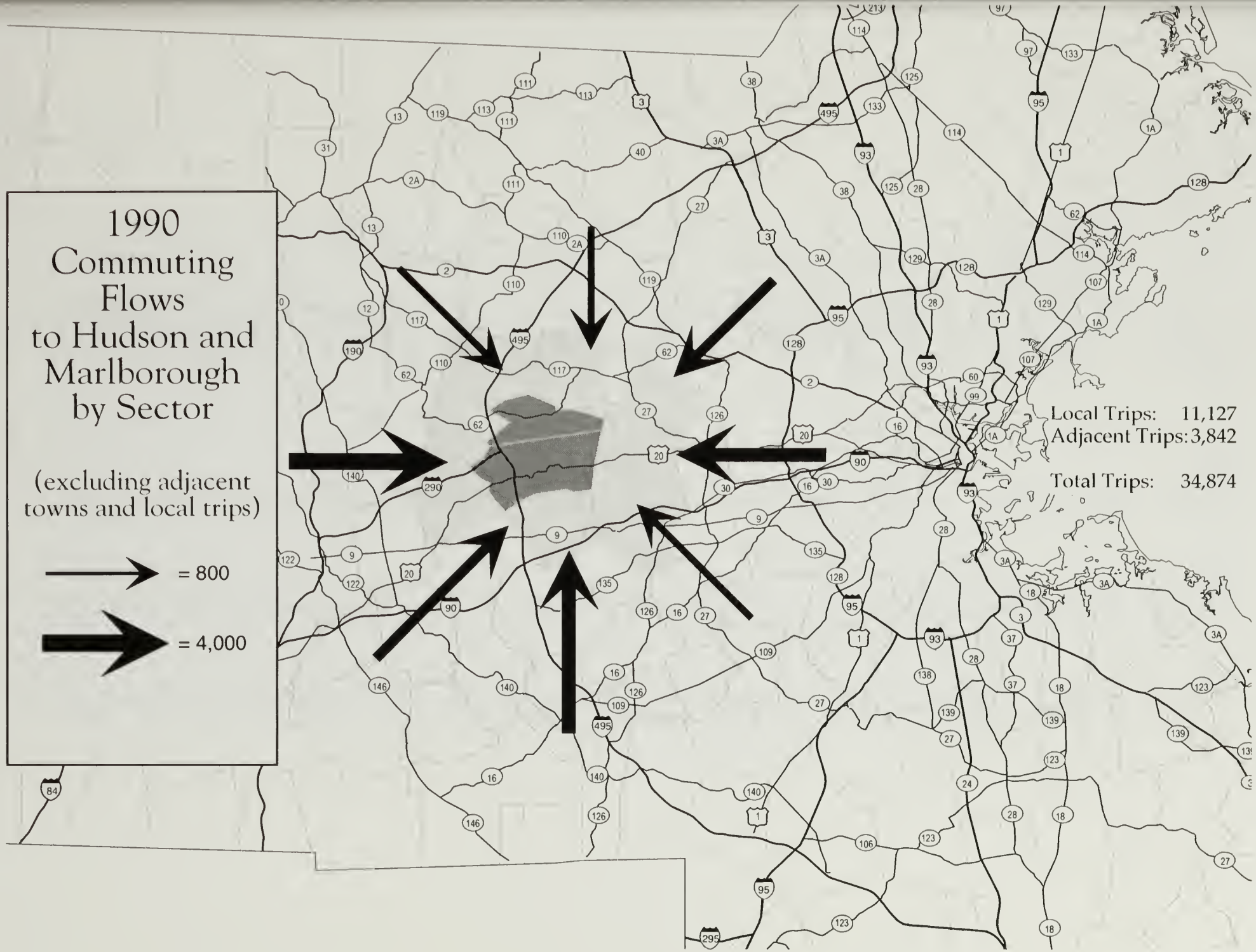

1990
Commuting
Flows
to Framingham
and Natick
by Sector
(excluding adjacent
towns and local trips)
= 1,000
= 7,000
Local Trips: 21,236
Adjacent Trips: 6,750
Total Trips: 54,120

Sector	Residence	Work in Framingham	Work in Natick	Combined
Local	Framingham	12,309	3,056	15,365
Local	Natick	1,655	4,216	5,871
	Total			21,236
Adjacent	Marlborough	1,157	386	1,543
Adjacent	Southborough	581	133	714
Adjacent	Ashland	1,639	480	2,119
Adjacent	Sherborn	103	139	242
Adjacent	Dover	45	116	161
Adjacent	Sudbury	423	107	530
Adjacent	Wayland	350	313	663
Adjacent	Weston	88	71	159
Adjacent	Wellesley	320	299	619
	Total			6,750
W	Athol	12	-	12
W	Berlin	37	4	41
W	Boylston	31	18	49
W	Clinton	72	65	137
W	Holden	6	13	19
W	Northborough	275	130	405
W	Shrewsbury	320	87	407
W	Sterling	9	-	9
W	West Boylston	49	7	56
W	Westborough	607	151	758
W	Worcester	648	351	999
	Total			2,892
SW	Auburn	123	56	179
SW	Charlton	30	-	30
SW	Douglas	63	20	83
SW	Dudley	22	31	53
SW	Grafton	196	58	254
SW	Hopedale	244	118	362
SW	Hopkinton	787	214	1,001
SW	Mendon	116	77	193
SW	Milford	1,199	430	1,629
SW	Millbury	33	11	44
SW	Northbridge	139	66	205
SW	Oxford	22	15	37
SW	Southbridge	26	5	31
SW	Sturbridge	15	11	26
SW	Sutton	26	31	57
SW	Upton	175	54	229
SW	Uxbridge	126	90	216
SW	Webster	36	-	36
	Total			4,665
S	Attleboro	40	13	53
S	Bellingham	490	288	778
S	Blackstone	146	101	247
S	Franklin	438	352	790
S	Holliston	1,062	461	1,523
S	Medway	363	272	635
S	Millis	239	293	532
S	Norfolk	55	91	146
S	North Attleborough	60	53	113

Sector	Residence	Work in Framingham	Work in Natick	Combined
S	Plainville	41	26	67
S	Rhode Island	781	160	941
S	Seekonk	-	10	10
S	Swansea	10	8	18
S	Wrentham	31	44	75
	Total			5,928
SE	Barnstable	8	-	8
SE	Berkley	5	-	5
SE	Bourne	14	-	14
SE	Bridgewater	48	35	83
SE	Brockton	138	54	192
SE	Carver	26	-	26
SE	Dartmouth	-	8	8
SE	Dighton	7	12	19
SE	East Bridgewater	9	32	41
SE	Easton	90	11	101
SE	Fairhaven	10	-	10
SE	Fall River	15	25	40
SE	Falmouth	7	8	15
SE	Foxborough	38	64	102
SE	Lakeville	7	-	7
SE	Mansfield	24	27	51
SE	Mashpee	-	14	14
SE	Medfield	133	121	254
SE	Middleborough	7	-	7
SE	New Bedford	43	80	123
SE	Norton	16	27	43
SE	Norwood	138	110	248
SE	Plymouth	6	17	23
SE	Plympton	2	-	2
SE	Raynham	22	-	22
SE	Sandwich	3	29	32
SE	Sharon	63	7	70
SE	Somerset	-	9	9
SE	Stoughton	39	30	69
SE	Taunton	28	22	50
SE	Walpole	140	105	245
SE	Wareham	11	10	21
SE	West Bridgewater	5	-	5
SE	Yarmouth	14	-	14
	Total			1,973
E	Abington	4	17	21
E	Arlington	99	60	159
E	Avon	15	6	21
E	Belmont	46	54	100
E	Boston	1,085	838	1,923
E	Braintree	58	40	98
E	Brookline	196	92	288
E	Cambridge	124	61	185
E	Canton	25	75	100
E	Chelsea	17	23	40
E	Cohasset	9	-	9
E	Dedham	42	61	103
E	Duxbury	5	8	13
E	Everett	29	-	29

Sector	Residence	Work in Framingham	Work in Natick	Combined
E	Hanover	18	11	29
E	Hanson	-	5	5
E	Hingham	52	11	63
E	Hull	22	24	46
E	Lynn	48	-	48
E	Malden	97	45	142
E	Marblehead	14	8	22
E	Marshfield	33	82	115
E	Medford	92	76	168
E	Melrose	47	7	54
E	Milton	36	49	85
E	Needham	173	245	418
E	Newton	471	505	976
E	Norwell	25	11	36
E	Pembroke	7	13	20
E	Quincy	182	120	302
E	Randolph	52	45	97
E	Revere	34	12	46
E	Rockland	42	11	53
E	Salem	63	21	84
E	Saugus	14	24	38
E	Scituate	17	16	33
E	Somerville	136	46	182
E	Swampscott	10	14	24
E	Watertown	168	60	228
E	Westwood	62	15	77
E	Whitman	20	14	34
E	Winthrop	5	-	5
	Total			6,519
NE	Amesbury	12	-	12
NE	Andover	32	19	51
NE	Atkinson	-	-	-
NE	Bedford	44	14	58
NE	Beverly	10	31	41
NE	Billerica	107	53	160
NE	Boxford	-	23	23
NE	Burlington	87	49	136
NE	Danvers	8	11	19
NE	Gloucester	-	9	9
NE	Groveland	-	5	5
NE	Hampton	5	-	5
NE	Haverhill	36	22	58
NE	Ipswich	7	10	17
NE	Kingston NH	-	7	7
NE	Lawrence	50	20	70
NE	Lexington	84	91	175
NE	Lincoln	32	14	46
NE	Manchester	10	15	25
NE	Merrimac	8	-	8
NE	Methuen	20	16	36
NE	Middleton	9	7	16
NE	Newburyport	6	-	6
NE	North Andover	8	3	11
NE	North Reading	-	6	6
NE	Peabody	39	36	75
NE	Reading	9	20	29

Sector	Residence	Work in Framingham	Work in Natick	Combined
NE	Salem NH	-	11	11
NE	Salisbury	6	-	6
NE	Stoneham	39	13	52
NE	Tewksbury	44	34	78
NE	Topsfield	5	-	5
NE	Wakefield	52	9	61
NE	Waltham	221	221	442
NE	Wilmington	26	6	32
NE	Winchester	15	42	57
NE	Woburn	57	19	76
	Total			1,924
N	Acton	114	34	148
N	Bedford NH	9	-	9
N	Carlisle	38	17	55
N	Chelmsford	72	26	98
N	Concord	64	45	109
N	Concord NH	11	-	11
N	Derry	8	-	8
N	Dracut	14	-	14
N	Dunstable	3	4	7
N	Hudson NH	22	17	39
N	Litchfield	-	5	5
N	Littleton	26	-	26
N	Londonderry	22	-	22
N	Lowell	88	37	125
N	Manchester NH	22	8	30
N	Maynard	119	76	195
N	Merrimack	8	-	8
N	Nashua	10	22	32
N	Pelham	5	-	5
N	Raymond	7	10	17
N	Westford	54	12	66
N	Windham	9	-	9
	Total			1,038
NW	Ayer	14	5	19
NW	Bolton	42	18	60
NW	Boxborough	6	18	24
NW	Fitchburg	41	7	48
NW	Gardner	26	-	26
NW	Groton	31	10	41
NW	Harvard	25	14	39
NW	Hollis	6	5	11
NW	Hudson	379	116	495
NW	Lancaster	46	28	74
NW	Leominster	93	27	120
NW	Lunenburg	18	14	32
NW	Mason	3	-	3
NW	Pepperell	23	8	31
NW	Shirley	-	8	8
NW	Stow	85	32	117
NW	Townsend	8	18	26
NW	Westminster	10	11	21
	Total			1,195
	Grand Total	35,349	18,771	54,120


1990
Commuting
Flows
to Hudson and
Marlborough
by Sector
(excluding adjacent
towns and local trips)
= 800
= 4,000
Local Trips: 11,127
Adjacent Trips: 3,842
Total Trips: 34,874

Sector	Residence	Work in Hudson	Work in Marlborough	Combined
Local	Hudson	2,720	1,380	4,100
Local	Marlborough	1,146	5,881	7,027
	Total			11,127
Adjacent	Berlin	85	136	221
Adjacent	Bolton	73	112	185
Adjacent	Framingham	271	1,016	1,287
Adjacent	Northborough	164	753	917
Adjacent	Southborough	29	250	279
Adjacent	Stow	125	285	410
Adjacent	Sudbury	100	443	543
	Total			3,842
W	Athol	5	22	27
W	Barre	7	32	39
W	Boylston	59	84	143
W	Clinton	241	460	701
W	Holden	22	145	167
W	Hubbardston	4	20	24
W	Leicester	33	52	85
W	Oakham	2	11	13
W	Orange	9	26	35
W	Paxton	-	22	22
W	Princeton	31	50	81
W	Rutland	-	18	18
W	Shrewsbury	143	643	786
W	Spencer	53	70	123
W	Sterling	24	178	202
W	West Boylston	47	70	117
W	Worcester	414	1,341	1,755
	Total			4,338
SW	Auburn	46	209	255
SW	Charlton	18	71	89
SW	Connecticut	20	68	88
SW	Douglas	23	42	65
SW	Dudley	5	9	14
SW	Grafton	57	275	332
SW	Millbury	71	166	237
SW	Northbridge	27	116	143
SW	Oxford	35	75	110
SW	Southbridge	8	58	66
SW	Sturbridge	32	28	60
SW	Sutton	46	93	139
SW	Webster	-	94	94
SW	Westborough	197	540	737
	Total			2,429
S	Ashland	30	262	292
S	Attleboro	14	78	92
S	Bellingham	27	207	234
S	Blackstone	8	67	75
S	Franklin	20	164	184
S	Holliston	12	149	161
S	Hopedale	6	56	62
S	Hopkinton	25	273	298
S	Medway	6	124	130
S	Mendon	7	101	108
S	Milford	57	493	550
S	Millville	-	10	10

Sector	Residence	Work in Hudson	Work in Marlborough	Combined
S	North Attleborough	9	38	47
S	Plainville	8	10	18
S	Rehoboth	-	13	13
S	Rhode Island	62	340	402
S	Seekonk	-	7	7
S	Swansea	-	14	14
S	Upton	34	98	132
S	Uxbridge	78	59	137
S	Wrentham	-	29	29
	Total			2,995
SE	Abington	-	7	7
SE	Acushnet	-	10	10
SE	Barnstable	-	7	7
SE	Bourne	-	7	7
SE	Brewster	8	-	8
SE	Bridgewater	-	6	6
SE	Brockton	-	43	43
SE	Canton	13	23	36
SE	Carver	-	11	11
SE	Dartmouth	9	-	9
SE	Dedham	-	5	5
SE	Dennis	-	13	13
SE	Dighton	-	6	6
SE	Dover	5	11	16
SE	Duxbury	15	9	24
SE	East Bridgewater	-	28	28
SE	Easton	9	51	60
SE	Foxborough	9	56	65
SE	Halifax	-	17	17
SE	Hanson	-	7	7
SE	Kingston	10	-	10
SE	Lakeville	-	31	31
SE	Mansfield	16	57	73
SE	Marion	-	16	16
SE	Medfield	5	68	73
SE	Middleborough	-	45	45
SE	Millis	-	59	59
SE	Natick	46	259	305
SE	Needham	44	70	114
SE	New Bedford	-	31	31
SE	Norfolk	-	23	23
SE	Norton	-	16	16
SE	Norwood	-	40	40
SE	Pembroke	-	10	10
SE	Plymouth	-	51	51
SE	Plympton	-	15	15
SE	Randolph	-	17	17
SE	Raynham	-	11	11
SE	Rochester	-	7	7
SE	Rockland	-	5	5
SE	Sharon	15	42	57
SE	Sherborn	-	24	24
SE	Stoughton	21	47	68
SE	Taunton	-	10	10
SE	Walpole	-	47	47
SE	Westwood	15	46	61
SE	Whitman	6	-	6
	Total			1,610

Sector	Residence	Work in Hudson	Work in Marlborough	Combined
E	Arlington	53	62	115
E	Belmont	18	29	47
E	Beverly	16	14	30
E	Boston	130	548	678
E	Braintree	-	37	37
E	Cambridge	13	95	108
E	Danvers	-	29	29
E	Gloucester	-	43	43
E	Hamilton	-	8	8
E	Hingham	-	16	16
E	Hull	5	8	13
E	Lexington	14	105	119
E	Lincoln	-	63	63
E	Lynn	-	27	27
E	Lynnfield	-	22	22
E	Malden	5	20	25
E	Marblehead	-	16	16
E	Marshfield	8	21	29
E	Medford	7	70	77
E	Melrose	-	34	34
E	Milton	6	18	24
E	Nahant	-	8	8
E	Newton	13	196	209
E	Norwell	9	-	9
E	Peabody	18	19	37
E	Quincy	-	17	17
E	Revere	11	-	11
E	Rockport	-	11	11
E	Salem	14	30	44
E	Saugus	6	26	32
E	Somerville	-	132	132
E	Stoneham	10	31	41
E	Swampscott	-	6	6
E	Wakefield	-	24	24
E	Waltham	11	222	233
E	Watertown	48	49	97
E	Wayland	24	148	172
E	Wellesley	6	107	113
E	Weston	6	39	45
E	Weymouth	9	21	30
E	Winchester	7	-	7
E	Winthrop	-	12	12
E	Woburn	-	46	46
	Total			2,896
NE	Acton	168	273	441
NE	Andover	13	50	63
NE	Atkinson	7	24	31
NE	Bedford	-	30	30
NE	Billerica	37	75	112
NE	Brentwood	-	3	3
NE	Burlington	11	48	59
NE	Carlisle	-	51	51
NE	Chelmsford	86	173	259
NE	Concord	12	98	110
NE	Danville	-	3	3
NE	Derry	23	11	34
NE	Dover NH	-	6	6
NE	Dracut	12	45	57
NE	Hampstead	-	11	11

Sector	Residence	Work in Hudson	Work in Marlborough	Combined
NE	Hampton	16	17	33
NE	Haverhill	6	37	43
NE	Ipswich	19	10	29
NE	Lawrence	-	10	10
NE	Lee	-	5	5
NE	Lowell	33	175	208
NE	Maine	16	2	18
NE	Maynard	164	175	339
NE	Merrimac	-	9	9
NE	Methuen	6	29	35
NE	Middleton	-	11	11
NE	Newburyport	-	29	29
NE	North Andover	-	51	51
NE	North Reading	-	48	48
NE	Pelham	-	6	6
NE	Plaistow	9	-	9
NE	Reading	8	53	61
NE	Salem NH	8	15	23
NE	Stratham	6	-	6
NE	Tewksbury	10	64	74
NE	Topsfield	16	19	35
NE	Wilmington	17	6	23
	Total			2,375
N	Amherst NH	-	38	38
N	Ayer	10	105	115
N	Boxborough	37	42	79
N	Brookline	18	111	129
N	Concord NH	6	-	6
N	Dunstable	6	8	14
N	Groton	6	103	109
N	Harvard	43	99	142
N	Hollis	-	30	30
N	Hudson NH	-	23	23
N	Littleton	69	110	179
N	Londonderry	8	-	8
N	Merrimack	18	28	46
N	Milford NH	-	10	10
N	Nashua	55	168	223
N	Pepperell	29	51	80
N	Tyngsborough	6	44	50
N	Westford	34	251	285
	Total			1,566
NW	Ashburnham	-	24	24
NW	Ashby	11	10	21
NW	Fitchburg	107	181	288
NW	Gardner	58	88	146
NW	Lancaster	68	141	209
NW	Leominster	201	408	609
NW	Lunenburg	14	90	104
NW	Mason	3	2	5
NW	Shirley	28	57	85
NW	Templeton	-	41	41
NW	Townsend	27	17	44
NW	Westminster	11	79	90
NW	Winchendon	13	17	30
	Total			1,696
	Grand Total	9,097	25,777	34,874

APPENDIX C

ROUTE 128 BUS SERVICE:
FEASIBILITY ANALYSIS FROM
1994 PROGRAM FOR MASS TRANSPORTATION

Route 128 Bus Service

This section summarizes the results of the PMT analysis of providing bus service on Route 128 between Beverly and Braintree.

Existing Conditions

The majority of public transit in the Boston region is a traditional hub-and-spoke network of commuter rail, bus, and rapid transit lines leading to downtown Boston. For suburb-to-suburb-commuting, which constitutes the majority of work trips made within and to the Boston area, transit has generally not been expanded due to difficulties in adequately serving dispersed trip origins and destinations. Development in the 1980s has increased the density of trip attractors (office, industrial and commercial employment) and trip producers (residential development) to the extent that it may be possible to institute successful suburb-to-suburb services.

Service Configuration for Route 128 Bus Service

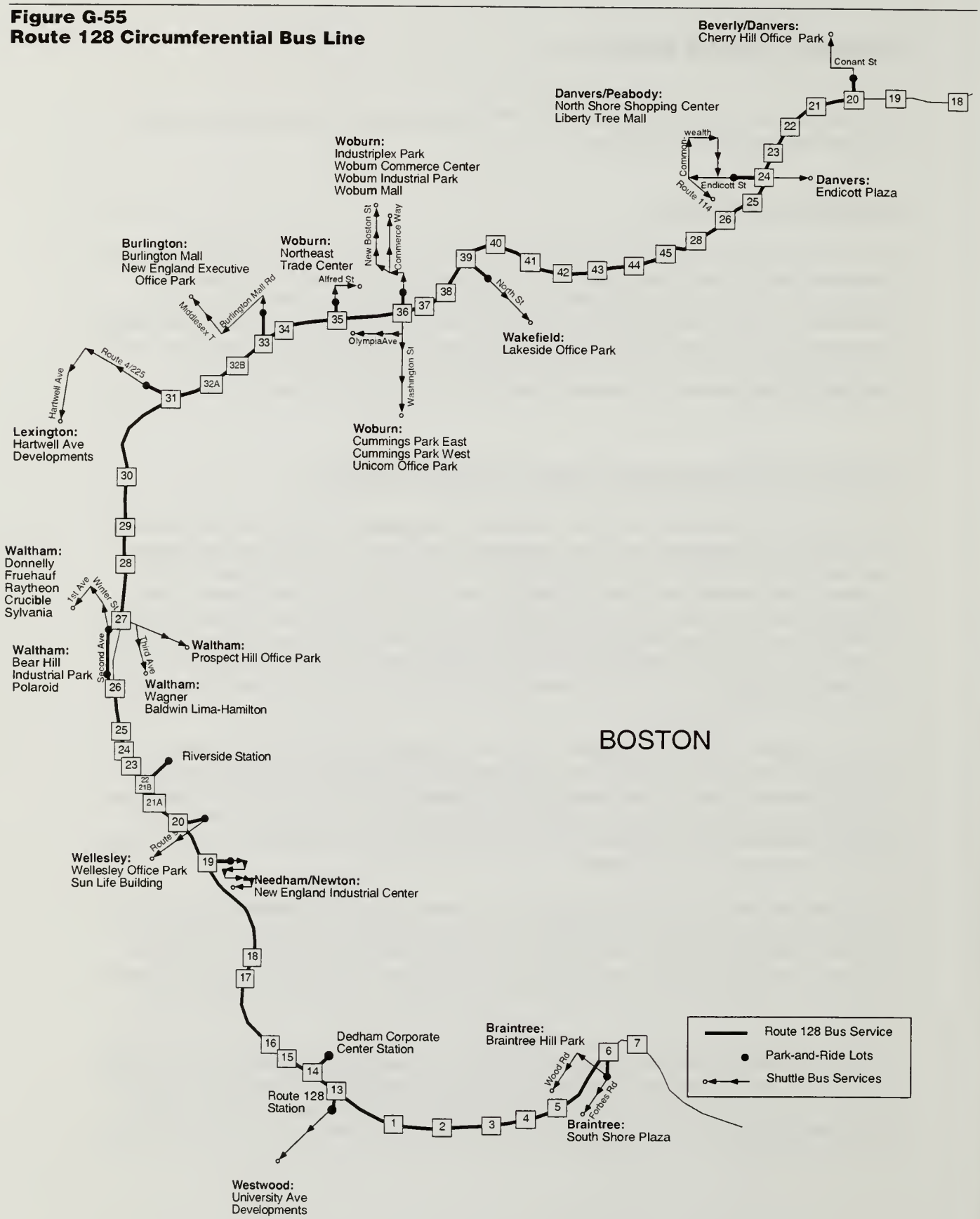
For a Route 128 bus service to be able to compete with automobile trips, it would need to be convenient, cost-competitive and have reasonable travel times. To make bus travel times reasonable, Route 128 service would need to stay on that highway to the greatest extent possible. Buses would leave Route 128 only to make stops at major interchanges. Local collection and distribution would be provided by park-and-ride lots located at these stops and by shuttle services to and from work sites. Most trips would involve two transfers. In the morning, the first would usually involve an automobile trip from home to the Route 128 bus at a stop at a park-and ride-lot. The second would be from the Route 128 bus to a shuttle to the final destination.

For the purposes of the PMT analysis, service was designed to serve the largest work trip attractors along the Route 128 corridor, with station sites selected to satisfy two criteria: (1) multiple major employment centers within a roughly 3.5 mile radius of the bus stop, and (2) the existence of local arterial roads that could provide good radial access. The second attribute is particularly important because it would minimize automobile travel time to and from the commuter's point of origin.

The trunk line service would operate 55.6 miles between Beverly and Braintree with 15 stops in 12 communities: one stop each in Beverly, Danvers, Wakefield, Burlington, Lexington, Newton, Wellesley, Needham, and Braintree, and two stops each in Dedham, Woburn and Waltham (see Figure G-55). Connections to other MBTA services could be made at Riverside (Green Line) and at the Dedham Corporate Center and Route 128 commuter rail stations.

Because employment density in the city of Waltham is very high, bus service would directly serve local developments between exits 26 and 27. The southbound alignment would be from Exit 27 on Route 128 to Second Avenue, Bear Hill Road, Main Street, Stow Street, Tavern Road and Route 20 back to Route 128 at Exit 26. This distance is approximately 2.5 miles. Major employment centers in this area include, among others, Polaroid and those in the Bear Hill Industrial Park.

Figure G-55
Route 128 Circumferential Bus Line



The service frequency would be 15 minutes during peak hours and 30 minutes in the off-peak Fares would be distance-based, ranging from 60c to $5.35. Parking at park-and-ride lots would be free except at rapid transit or commuter rail stations, where existing fees would be maintained.

Park-and-Ride Lots

Many potential Route 128 bus riders live in areas that do not have bus service. Therefore, park-and-ride lots would be necessary to provide for auto access to the route. For this analysis, in order to determine the maximum ridership potential, it was assumed that park-and-ride lots would be located at each interchange that would be served by a Route 128 bus route. Further, all park-and-ride lots would be located immediately adjacent to these interchanges (to minimize off ramp and on ramp travel time) unless otherwise noted. Parking for at least 100 cars would be provided and offered free of charge. Stops and park-and-ride lots would be located at the following locations:

Interchange	Radial Collector/Distributor	Community
Exit 20	Route 1A	Beverly
Exit 24	Endicott Street	Danvers
Exit 39	North Street	Wakefield
Exit 36	Washington Street	Woburn
Exit 35	Route 38	Woburn
Exit 33	Route 3A	Burlington
Exit 31	Route 4/225	Lexington
Exit 27	Winter Street	Waltham
Exit 26	Route 20	Waltham
Exit 22/21B	Riverside Station	Newton
Exit 20	Route 9	Wellesley
Exit 19	Highland Avenue	Needham
Exit 14	Dedham Corporate Center Station	Dedham
Exit 13	Route 128 Station	Dedham
Exit 6	Route 37	Braintree

Employer-Provided Shuttle Services

Shuttle services would provide connections between bus stops and work sites. For this purpose, it was assumed that shuttle services would operate at the same frequency as the Route 128 bus, with timed connections. This would involve sixteen separate shuttle services with run times of between 8 and 23 minutes. Shuttle bus trip lengths would range from approximately 1.5 miles in Wakefield to 3.5 miles in Lexington. The shuttle services would serve the following work sites:

1) To and from the vicinity of Exit 20 in Beverly via Route 1A, Conant Street to Cherry Hill Drive. This service is designed to serve the Cherry Hill Office Park in Beverly and Danvers. Large employers include Dynapert Incorporated, Eaton Corporation, and Emhart Industries, Inc.

2) To and from the vicinity of Exit 24 in Danvers via Endicott Street (west of Route 128), Commonwealth Avenue, Independence Way and Andover Street (Route 114)—this service is designed to serve developments in Danvers and Peabody including the Liberty Tree Mall and the North Shore Shopping Plaza. Among the area's largest employers are Demoulas'

Super Markets, Inc., K Mart Corporation, Sears Roebuck, May Department Stores Co., Century House of Peabody, Inc., and Essen Foods, Inc.

3) To and from the vicinity of Exit 24 in Danvers via Endicott Street (east of Route 128)—this service is designed to serve Endicott Plaza including GTE Corporation and the Visiting Nurse Association North Shore, Inc.

4) To and from the vicinity of Exit 39 in Wakefield via North Street—this service is designed to serve the Lakeside Office Park among other developments. Major employers include American Patriot Group, Inc., DAKA International, Inc., Sumaria Systems, Inc., and Systems Automation, Inc.

5) To and from the vicinity of Exit 36 in Woburn via Washington Street, New Industrial Road, Commerce Way and New Boston Street (north of Route 128) serving the Woburn Mall, Woburn Commerce Center, Woburn Industrial Park and Industri-plex among others. Major employers include Globe Data Systems, Inc., Steinbrecher Corp., Laidlaw, Inc., Lintec of America, Inc., Locke Manufacturing Co., Inc., the Savings Bank Life Insurance Council, and Loral Hycor Inc.

6) To and from the vicinity of Exit 36 in Woburn via Washington Street and Olympia Avenue (south of Route 128) serving Cummings Park West, Cummings Park East, and Unicorn Office Park. Major employers include Days Inns of America, Inc. and Marshalls, Inc.

7) To and from the vicinity of Exit 35 in Woburn via Route 38 to Alfred Street—this service is designed to serve the Northeast Trade Center among other developments.

8) To and from the vicinity of Exit 33 in Burlington via Route 3A, Burlington Mall Road and the Middlesex Turnpike—this service could potentially serve more than 300 employment sites, the largest of which include BayBank Middlesex, Hewlett-Packard Company, Rolm Company, May Department Stores Co., Digital Equipment Corporation, Wausau Mutual, the Lahey Clinic, M/A-COM, Inc., First National Bank of Boston, Xylogics, Inc., Jordan Marsh, and Sears Roebuck.

9) To and from the vicinity of Exit 31 in Lexington via Route 4/225 to Hartwell Avenue—this service is designed to primarily serve the many businesses on Hartwell Avenue. Major employers include Fisher Scientific Company, Litton Systems, Inc., McGraw-Hill, Inc., Private Health Care Systems, Rolm Company, Varian Associates, Inc., and MIT/Lincoln Laboratory.

10) To and from the vicinity of Exit 27 in Waltham via Winter Street to First and Second avenues —this service is designed to serve the area's major employers which include Automatic Data Processing, Inc., GTE Government Systems Corp., Cabot Corporation, and Polaroid Corporation.

11) To and from the vicinity of Exit 27 in Waltham via Totten Pond Road to Prospect Hill Lane, Third Avenue and Fourth Avenue—this service is designed primarily to serve Prospect Hill Office Park. Major employers include M/A-COM, Inc., Information Resources, Inc., and Pepsi-Cola.

12) To and from the vicinity of Exit 20 in Wellesley via Route 9—this service is designed to serve the Sun Life Building and Wellesley Office Park among other developments. Major employers include EG&G Inc., Wyatt Company, Unisys Corporation, Whitman & Howard, Inc., Eastman Kodak Company, and Sun Life of Canada U.S.

13) To and from the vicinity of Exit 19 in Needham (east of Route 128) via Highland Avenue—this service is designed to serve the industrial developments on Cabot Street, A and B Streets, First, Second and Third and Fourth Avenues. Major employers include Damon Corporation, Duracell Holdings Corporation, GWV Travel, GTE Corporation, Coca Cola Company, and Hearst Corporation.

14) To and from the vicinity of Exit 13 in Dedham—this service is designed to serve the University Avenue complex in Westwood. Major employers include LTX Corporation, HUB Mail Advertising Service, PB Diagnostic Systems, Inc., Alco Standard Corporation, MIB, Inc., and Faxon Company.

15) To and from the vicinity of Exit 6 in Braintree (south of Route 128)—this service is designed to serve Forbes Road developments and the South Shore Plaza. Major employers include Blue Cross Blue Shield, Flatley Company, and Community Habitat, Inc.

16) To and from the vicinity of Exit 6 in Braintree (north of Route 128)—this service is designed to serve Wood Road developments and the Braintree Hill Park. Major employers include Blue Cross Blue Shield, Haemonetics Corporation, Semline, Inc., and Johnson & Johnson.

Ridership Impacts

Bus service on Route 128 with park-and-ride lots and connecting shuttle services would carry approximately 3,470 trips per weekday. Virtually all of these would be new transit trips. Nearly all of the passengers (98 percent) would access the service by automobile, and most of the trips would be relatively long (an average of 13.5 miles). The relatively long trip length is a consequence of transfers being required at both ends, since the time and inconvenience of the transfers would be more of a disincentive for shorter trips than for longer ones.

Table G-91
Route 128 Bus Ridership

	Total Trips	New Transit Trips
Route 128 Circumferential Bus Service	3,470	3,470

With 3,470 new transit trips per weekday, Route 128 bus service would divert a high number of trips from automobiles to transit—more than any commuter rail project except the North Station - South Station Rail Link, and more than most rapid transit projects. However, a very large amount of new service would be needed to attract this ridership. At 55.6 miles, this route would be, by far, the longest in the MBTA system. In proportion to the amount of new service that would be provided, ridership would be low. The number of total passengers per vehicle service mile (VSM), and per vehicle service hour (VSH), would be 0.7 and 12.0 respectively. These figures are well below the MBTA's minimum service standards of 1.5 passengers per VSM and 30 passengers per VSH for bus service.

Further, it should be stressed that the full 3,470 trips could be attracted only if the bus service were supported by the park-and-ride lots and shuttle services. Few trips would be made by passengers that could walk to the bus at both ends. As a result, if Route 128 bus

service were instituted without these supporting facilities and services, ridership would be extremely low.

Costs and Cost-Effectiveness

The institution of bus service along Route 128 would require a number of actions:

1) Construction of park-and-ride lots and associated stop facilities.
2) Purchase of buses.
3) Institution of connecting shuttle services.

The construction of park-and-ride lots and stop facilities and the purchase of the 24 buses needed to operate the service would cost $7.9 million (see Table G-92). The connecting shuttle services, if contracted for in the same manner as most existing suburban mini-bus services would not have an associated capital cost; capital costs instead would be built into the contract cost for the operation of the service. The $7.9 million total would result in a capital cost per new transit rider of $2,300. This would be one of the lowest such costs among PMT projects that would generate significant new ridership.

Table G-92
Cost-Effectiveness of Route 128 Bus Service

	Operating Cost (Annual)	Fare Revenue (Annual)	Capital Cost[55]	Capital Cost/ New Trip
Route 128 Circumferential Bus Service	$4.8m	$0.9m	$7.9m	$2,300

Because of the length of the route, and the level and span of service that would be provided, operating costs would be high, at $4.8 million per year. The new ridership, which would be low compared to the amount of new service provided, would generate $0.9 million in new fare revenue, or 17.9 percent of operating costs. This percentage is low, but is similar to the 21.5 percent ratio for all existing MBTA bus service combined.

Air Quality Impacts

Route 128 bus service would have a relatively large positive benefit on air quality, resulting in a reduction in regional emissions of 0.05 percent. The resulting capital cost per kilogram of VOC eliminated ($179,000) would be higher than those of most other PMT bus projects, but much lower than those of all PMT rail projects.

[55]Costs do not include land acquisition.

Table G-93
Air Quality Impacts of Route 128 Bus Service

	% Reduction Regional Emissions	Capital Cost/kg of VOC Elim/weekday
Route 128 Circumferential Bus Service	0.05%	$178,700

Conclusions

Route 128 bus service could divert a relatively large number of automobile users—3,470 per weekday—to transit. Further, the capital cost of implementing the service ($7.9 million) would be low relative to the number of new riders that would be attracted.

However, there are also a large number of negatives to the service. First, it would be expensive to operate ($4.8 million per year), and be lightly utilized relative to the amount of service that would be provided. In terms of the number of passengers per vehicle service mile and per vehicle service hour, a Route 128 bus route would perform well below minimum MBTA standards.

Also, the PMT analysis assumed a cooperative effort whereby the MBTA would provide the Route 128 service and the connecting shuttle services would be locally financed and operated. This would require a major (and probably time-consuming) effort on the part of the MBTA and local cities, towns, developers, and/or transportation management agencies to set up connecting shuttle services. If, as an alternative, the MBTA were to finance and operate the connecting services, operating costs would be significantly higher.

Finally, it should be noted that the PMT analysis examined only one alternative for Route 128 bus service, and that this alternative was designed to provide service to the entire corridor. The resulting ridership projections indicate that there is a demand for service, but not for the level or extent of service that was examined. It is possible that more modest bus services could achieve much of the same ridership increases at lower costs. The examination of additional options was beyond the scope of the PMT analysis; subsequent work on Route 128 bus services should focus on this area.